EVOLUTION OF UNMANNED AERIAL WARFARE: A HISTORICAL LOOK AT REMOTE AIRPOWER—A CASE STUDY IN INNOVATION

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE
Art of War Scholars

by

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ABSTRACT

EVOLUTION OF UNMANNED AERIAL WARFARE: A HISTORICAL LOOK AT REMOTE AIRPOWER—A CASE STUDY IN INNOVATION, by Maj Bishane A. Whitmore, 120 pages.

American unmanned aircraft interest has exploded in popularity and as a divisive issue in recent years. The history of these systems is not widely known, especially their use prior to the war in Afghanistan and Iraq. This thesis seeks to examine how unmanned aircraft were used in pre-21st century conflicts and the missed opportunities in development that emerged due to budgetary constraints, leadership personalities, and technological hindrances. This paper looks at balloon warfare, the Kettering Bug during World War I, the birth of "drones" during the interwar years and the OQ-2 Radioplane and remote controlled B-17s during World War II. The thesis further looks at the use of the Firebee during the Cold War and the use of the Lightning Bug during Vietnam. Ultimately, the analysis shows how development of unmanned aircraft is a cautionary tale to continue research and development while being prepared for cultural shifts the technological era presents.

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ACRONYMS

AGL	Above Ground Level
CIA	Central Intelligence Agency
ISR	Intelligence, Surveillance, and Reconnaissance
MARS	Mid-Air Retrieval System
RPA	Remotely Piloted Aircraft
RPV	Remotely Piloted Vehicle
SAM	Surface-to-Air Missile
SIGINT	Signals Intelligence
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle

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CHAPTER 1

INTRODUCTION

> Although many experimenters have addressed themselves to the problem within the last few years—and these have included men of education and skill—the general failure to arrive at any actual flight has seemed to throw a doubt over the conclusions which I had announced as theoretically possible. When, therefore, I was able to state that on May 6, 1896, such a degree of success had been attained that an aerodrome, built chiefly of steel, and driven by a steam engine, had indeed flown for over a half a mile—that this machine had alighted with safety and performed a second flight on the same day, it was felt that an advance had been made, so great as to constitute the long desired experimental demonstration of the possibility of mechanical flight.
>
> — Samuel Pierpont Langley,
> *Langley Memoir on Mechanical Flight*

Embers of Unmanned Flight

The allure of unmanned aircraft systems (UASs) has ebbed and flowed in American history for many years. While early on their use may not have had the same impact as other military systems, the influence of UAS on the military has exponentially grown over the past century. The 21st century revealed the marriage of cost effectiveness and technological capabilities resulting in an explosion of research, development, and operational use. Aircraft such as the RQ-4 Global Hawk, MQ-1B Predator, MQ-9 Reaper, and RQ-170 Sentinel have transformed the nature of unmanned aerial combat. These systems have proven their effectiveness across the globe in numerous areas of operation, in multidimensional roles, satisfying the demands for intelligence, surveillance, and reconnaissance (ISR) for senior leaders, operational units, and intelligence professionals. Recent conflicts in Iraq and Afghanistan have created requirements for increased information, both imagery and signals, and pinpoint weapons delivery to mitigate

collateral damage. Unmanned aircraft have altered traditional notions of force projection and battlefield integration. At the same time, the concepts of unmanned systems have gone from an unknown theory to a much-discussed reality.

UASs' capabilities have proven indispensable to ground commanders because of the situational awareness they provide through imagery, near real-time video, or various signals intelligence. To meet demands, development continued for enhanced loiter capability, weapons arsenal, improved speed and altitude envelopes, and signature reduction. The UASs' onboard camera systems are increasingly more complex with higher fidelity and functionality. Additionally, the advent of satellite communication to control larger UASs over long distances has opened new considerations in warfare. The rapid arrival of UASs and digital technology, have spawned a new revolution of military affairs in which new technology allows for military action at substantial distances while removing many of the intimacies of combat.[1]

Despite numerous news reports and commentaries, one of the most mistaken perceptions about UASs is that they are relatively new systems. It appears that most people believe they originated in the early 21st century as a method to combat terrorist sects in response to the World Trade Center attacks on 11 September 2001. In fact, American unmanned aircraft date back to the late 19th century.

[1] Ann Rogers and John Hill, *Unmanned: Drone Warfare and Global Security* (New York: Pluto Press, 2014), 144-146. In this book Rogers and Hill discuss how Indian Air Vice Marshall Kapil Kak believed that UASs were sweeping away the traditional notions of front lines. Soon these technologies will have the capability to blend land, sea, and air in ways never before imagined by stretching battle spaces forward and backward in space and time. What used to be rare, real-time information and instant communications will no longer be a force multiplier but will become a force requirement as decision cycles become compressed. Information dominance has proven crucial to air superiority.

Balloon warfare was one of the first types of aerial combat. In 1794, the French realized the possibilities for domination of the air by creating the *compagnie d'aérostiers,* the first manned balloon corps. The Montgolfier brothers, developers of the hot-air balloon, saw the potential for balloons to affect the battlefield.[2] Balloons provided observation and potential elementary strike capability from the air. While not advanced enough to change the course of a war, balloons indeed provided an avenue for technological innovation.[3]

A memoir published in 1851 by Leopoldo Crilanovich, described the 1849 Austrian siege of Venice when unmanned balloons were used to employ ordnance on enemies. The Italian War for Independence of 1848 to 1849 spurred from Austrian rule over Venice and commenced when Napoleon ceded Venice to Austria in 1797. Austria promised Venice home rule, but the Venetians demanded complete independence. By 1845, Austrians had decimated capitalism in Venice because of poor economic practices; as a result, the Venetians' revolted. The Austrians were the first to use balloons as airborne force projection. On 22 August 1849, they launched 200 pilotless balloons mounted with bombs when the wind blew toward Venice.[4] The 23-foot-diameter balloons, which carried 30-pound bombs, functioned with timers and were detonated via a fuse—once the timers expired, the balloon exploded and bombs dropped onto the city.

[2] Rogers and Hill, 12-13.

[3] Jay Mallin Sr. and Robert Scheina, "Innovative Technologies and American Soldiers of Fortune," *Army Magazine* 64, no. 9 (2014): 76.

[4] Ian G. Shaw, "The Rise of the Predator Empire: Tracing the History of U.S. Drones," Understanding Empire, 2014, accessed 25 August 2015, https://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/.

The Austrians used balloon warfare because it was simpler than traversing lagoons with artillery.[5] This method of aerial bombardment presented numerous technological challenges. The uncontrolled, unmanned balloons rarely hit the intended targets because of the changing wind that, in some cases, directed balloons back over Austrian territory.[6] However, balloons were useful for aerial reconnaissance by the early 1850s.[7]

Seeds of Innovation

In 1862, the concept of unmanned balloon warfare made its way to the United States during the American Civil War. The Confederate and U.S. forces flew manned balloons for reconnaissance and dropped bombs to destroy infrastructure.[8] Aerial warfare technology was still elementary, but the U.S. military began to see the air's potential as a domain for exploitation.[9] Nearly 30 years later, during the 1898 Spanish-American War, the US Army outfitted kites with cameras, which produced the first-ever aerial

[5] Dave Sloggett, *Drone Warfare: The Development of Unmanned Aerial Conflict* (New York: Skyhorse Publishing, 2015), 8-9. Slogett discusses how an article in *Scientific American* during that time suggested that up to 25 bombs a day might be delivered into the city. During one of these attacks, one of the bombs detonated over St Mark's Square. It was soon realized that balloons were not the right platform because of their uncontrollability.

[6] Rogers and Hill, 13.

[7] Jeffrey Stamp and Robert Scheina. "Aero-Static Warfare: A Brief Survey of Ballooning in Mid-nineteenth-century Siege Warfare," *Journal of Military History* 79, no. 33 (July 2015): 770.

[8] Shaw.

[9] James P. Meger, "The Rise of the Unmanned Aerial Vehicle and Its Effect on Manned Tactical Aviation" (Master's thesis, U.S. Army Command and General Staff College, Fort Leavenworth, KS, June 2006), 1.

reconnaissance photography.[10] At this point, balloon and kite warfare were limited in speed, range, control, and accuracy, and required a more capable platform.

Figure 1. Balloon Warfare during the Civil War

Source: Ian G. Shaw, "The Rise of the Predator Empire: Tracing the History of U.S. Drones," Understanding Empire, 2014, accessed 25 August 2015, https://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/.

In the 1890s, nearly a decade before the Wright brothers made their historic flight at Kitty Hawk, American astronomer and physicist Dr. Samuel Pierpont Langley pioneered aviation in the United States. He created an apparatus that could be heavier than air, yet still produce enough lift to break the "surly bonds" of Earth's gravity.

[10] Shaw. There is no record of reconnaissance photos taken from manned-balloons in the Civil War despite efforts to capture images. One problem was timing. The battlefield was too dynamic and changed too quickly for photography development to be relevant in a timely manner. In the paper, "Uninhabited Combat Aerial Vehicles," by Lt. Col. Richard Clark, he proposes the advent of kite use; nearly two thousand years ago in China, a man on a hill flew the world's first RPV consisting of a kite with a piece of string as a downlink to the controller on the ground. Additionally, Han Hsin, an ancient Chinese general, used kites to triangulate the distance for a tunnel his army used under a besieged city's walls in 202 B.C. In Europe, kite use dates back to second century; at that time, kites were used for signaling at the Battle of Hastings in 1066.

Langley built a quarter-scale "aerodrome" launched from a spring-driven catapult on his houseboat while on the Potomac River.[11] On 6 May 1896, Langley successfully launched Aerodrome No. 5, a small, unmanned aircraft that flew 150 feet above ground level (AGL) at a speed of approximately 25 miles per hour, for a distance of a half a mile over the Potomac River near Quantico, Virginia. This flight ushered in a new era of aviation. A 1.5-horsepower internal combustion engine propelled his No. 5 and No. 6 models. The No. 6 version flew 350 feet AGL and a distance of 4,790 feet.

Langley failed when he attempted a full-scale model called Aerodrome A, a two-propeller, 52-horsepower gasoline engine that was built to carry a pilot. Aerodrome A crashed on takeoff on 7 October 1903, due to the aircraft becoming snagged in the launch system and resulting in failure upon takeoff. On 8 December 1903, Langley's next attempt failed when it collapsed midair. Unfortunately, the aircraft was complex, aerodynamically flawed, and structurally weak. Langley's second failure ended his aeronautical work.[12]

World War I - Flying Bombs

In the summer of 1914, World War I, also known as The Great War, commenced with the assassination of Archduke Franz Ferdinand of Austria, heir to the throne of Austria–Hungry. Despite numerous actors and challenges, America, like the British,

[11] Nan Siegel and Robert Scheina, "Legacy of Flight," *Aviation History* 13, no. 6 (July 2003): 74.

[12] Ibid. The manned flights were piloted by Charles M. Manly, Langley's chief engineer. The two manned flights were unsuccessful and Manly was not hurt in either incident; however, the failures permanently dampened public support for Langley's aeronautical experiments leading to his abandonment of such work.

focused on defeating German U-boats and gathering intelligence. The Great War created the first modern concept of UASs and the advantages they could bring to the war effort.[13] During the war, aerial surveillance became a staple of force enhancement. Analysts stitched photos into mosaics to piece together the reconnaissance they gathered. For example, over five months during the Battle of the Somme, the Royal Flying Corps took over 19,000 aerial photographs, culminating in 430,000 prints, which improved map accuracy and provided leadership with increased situational awareness.[14]

During World War I, both the U.S. Army and Navy experimented with aerial torpedoes to counter the U-boat threat.[15] The Army's interest in aerial torpedoes originated from the technology race of Allied and Axis power nations experimenting with wireless telegraphy and fixed-wing aviation. The Army was searching for a way to break the stalemate caused by trench warfare, and the United States looked for an advantage in the skies. The U.S. Army Signal Corps entered World War I with few air assets and looked to expand after 1908. Years earlier, in 1858, the first transatlantic telegraph ushered in a new possibility for connectivity. By 1898, a private company named Tesla harnessed long-distance transmissions, called telegraphy, for operational use in the United States. Telegraphy, as a form of the electromagnetic spectrum, linked to fixed-wing technology during World War I and began the growth of the industry.

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[13] John F. Keane and Stephen S. Carr, "A Brief History of Early Unmanned Aircraft," *John Hopkins APL Technical Digest* 32, no. 3 (2013): 559.

[14] Shaw.

[15] Keane and Carr, 559.

In order to realize the potential for unmanned, remote aviation, an inventor named Elmer Ambrose Sperry and his radio engineer, Peter Hewitt, created the Hewitt–Sperry Automatic Airplane for the Navy, a rudimentary technology demonstrator. Sperry recognized, in 1911, that gyrostablization was crucial to a successful radio-controlled aircraft. In 1915, Sperry and Hewitt created the Curtiss-Sperry "flying bomb," which was laden with over 300 pounds of explosives and designed to travel upwards of 50 miles at 90 miles per hour. These aircraft used wood and fabric airframes and either gyroscope or propeller revolution counters to carry payloads.[16] This original flying bomb proved the value of autopilot functions tied to a gyrostablization unit; however, the Curtiss-Sperry aircraft were quickly developed and never flight-tested nor evaluated in wind tunnels; as a result, they failed their trials. On 6 March 1918, the longest flight of the Curtiss-Sperry flying bomb was only 1,000 feet long.[17]

In early 1917, the Army asked Charles Franklin Kettering to design another unmanned "flying bomb" with long-range capabilities. Kettering was an engineer and a member of an Army Signals Corps board tasked to evaluate the Curtiss-Sperry flying bomb for Army use.[18] Kettering developed the "Kettering Bug," also known as the "Aerial Torpedo," which was 300-pounds (including a 180-pound warhead) and launched

[16] Shaw. The name Curtiss in Curtiss-Sperry came from the Curtiss N-9 seaplane trainers the U.S. Navy provided to Sperry.

[17] H. R. Everett, *Unmanned Systems of World Wars I and II, Intelligent Robotics and Autonomous Agents* (Cambridge, MA: The MIT Press, 2015), 251. The failure of the Hewitt-Sperry trials led to an end in the Navy's interest in flying bomb technology and a discontinuation for further testing.

[18] Everett, 251. Five days after the United States declared war on Germany in April 1917, Kettering and his staff took over the remnants of the 1909 Wright Company and formally established the Dayton-Wright Airplane Company.

via a dolly-and-track system. Developed in Dayton, Ohio, the Kettering Bug used a small four-cylinder, air-cooled, 40-horsepower (at 2,000 rotations per minute) de Palma engine. It could fly at a speed of 55 miles per hour for a maximum range of 40 miles. The Bug had a wingspan of 15 feet and a length of 12.5 feet. The fuselage was made of plywood and cardboard; the spars, ribs, and so on were left over or defective pieces of spruce and the wing surfaces were covered in muslin paper. All parts were quickly detachable and special packing cases allowed two men to pack the Bug completely within five minutes.[19]

The Kettering Bug was designed to be guided to the target by a system of pre-set, vacuum-pneumatic, and electric controls. It hit its target through calculation input before flight, which included intended the trajectory, the winds forecasted en route, and the predicted number of engine revolutions to reach its destination. When the aircraft neared the end of its flight and the estimated revolutions elapsed, a special control closed, an electric circuit shut off the engine and fired detonators, which jettisoned the wings. The aircraft then fell toward the target, its onboard explosives detonating on impact.[20]

The static nature of World War I made the development of unmanned aircraft appealing. Unfortunately, the war ended before the system saw combat use, due to reliability concerns and the risk of flying over allied troops. By the end of World War I in

[19] World's First Guided Missile: Kettering Bug, Speeches dedicating Kettering Bug to Air Force Museum, March 14, 1964, Box K289.9201-1, Air Force Historical Research Agency, Maxwell Air Force Base, AL. The development of the Kettering Bug was a classified secret. Early planning was done in private homes and the testing was even done at dusk to keep the public from seeing the pilotless aerial torpedo. When Kettering took over the development of the aerial torpedo for the Army, Orville Wright was a consultant on flying features, Elmer Sperry consulted regarding controls, and C. H. Willis from Ford Motor Company helped develop to the engine.

[20] Keane and Carr, 559-661.

1918, Kettering had produced 45 of his Bugs. The technology and aircraft remained a secret until World War II; however, the benefits of unmanned airpower resulted in U.S. investment, which evolved at a rapid pace. The development of the Bug was also a precursor for a trend with unmanned aircraft, in which spikes of research and development met cycles of stagnation and digression in advancement. Senior Army leadership recognized that the potential for this type of system was important. The Army recommended developments continue because the weapon had considerable possibilities if the reliability and accuracy improved. Kettering applied for, and received, a patent on the control system, but peace and scarcity of funds interfered with further development until World War II.

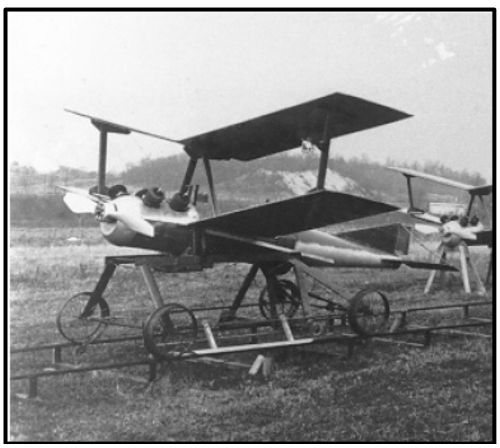

Figure 2. The Kettering Bug Aerial Torpedo

Source: Ian G. Shaw, "The Rise of the Predator Empire: Tracing the History of U.S. Drones," Understanding Empire, 2014, accessed 25 August 2015, https://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/.

Thesis Intent and Research Questions

The history of unmanned aircraft within the Army and Air Force provide a unique chance to learn from institutional development patterns of behavior and utilization. The use of UASs in historical conflicts and wars shows a progression of technology as a blueprint for future projects. The starting point—and primary research question—pertains to assessing how the U.S. Air Force and predecessors used unmanned aircraft in major conflicts from World War II (1939–1945) to Vietnam (1961–1973). Dissecting the primary research question will provide the opportunity to address secondary and tertiary questions and completely analyze the topic.

The secondary questions are important because they can provide insights into the U.S. military mindset and weaknesses in the development process. Secondary questions include: Was there a thread of missed opportunities in the development of UAS technology in which progression was stifled for political or budgetary reasons that ultimately led to underdevelopment of unmanned systems and programs? Additionally, what were the sentiments of manned aircraft pilots regarding UASs? Was there generalized acceptance of these technologies or was there an internal aversion to a concept that potentially threatened the aviation status quo? The tertiary question focuses on what programs improved the capabilities of the operators. The tertiary question is, what type of doctrine or training programs were developed for UAS crews in order to standardize operations and ensure proficiency? Investment into doctrine and training show an acceptance of what UAS capabilities bring to the fight and are building blocks for longevity.

Assumptions

Several key assumptions ensure that this thesis remains focused on the primary research question. The first assumption is that there will be sufficient information on unmanned aircraft during the conflicts ranging from World War II to Vietnam to discuss the topic in depth. The second assumption is that documentation of technological advancements in unmanned aircraft exists in military and civilian reports, journals, and other accessible unclassified published works. The last assumption is that senior leaders have used unmanned aircraft often enough to make a marked change in operational execution.

Definitions

The Air Land Sea Application Center publishes the *UAS Multi-Service Tactics, Techniques, and Procedures for the Tactical Employment of Unmanned Aircraft Systems* and uses the following joint definitions:

Unmanned Aircraft (UA): "is an aircraft that does not carry a human operator and is capable of flight with or without human remote control."[21]

Unmanned aircraft system (UAS): "is a system whose components include the necessary equipment, network, and personnel to control an unmanned aircraft."[22]

Unmanned aerial vehicle (UAV): "is a powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously

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[21] Air Land Sea Application Center, *UAS Multi-Service Tactics, Techniques, and Procedures for the Tactical Employment of Unmanned Aircraft Systems* (Joint Base Langley-Eustis, VA: Air Land Sea Application Center, 2015), 96.

[22] Ibid.

or be piloted remotely, can be expendable or recoverable, and carry a lethal or nonlethal payload."[23]

For the purpose of this paper, the outlined definitions will be used; however, for continuity the term UAS is primarily used. Gliders, blimps, balloons, ballistic or semi-ballistic vehicles, or artillery projectiles are not considered as UAVs.[24] The term UAV became common military vernacular in the 1990s, thus replacing the term remotely piloted vehicle (RPV), which was used during Vietnam.[25] Lastly, this paper will define RPVs and remotely piloted aircraft (RPA) synonymously with UAVs, although the Air Force strictly refers to its Group 4 and 5 unmanned aircraft as RPA to emphasize that their operators are trained to the same standards as manned-aircraft pilots.[26]

Limitations and Delimitations

This thesis will remain unclassified through the use of open source materials. The main limitation is any primary source material that requires travel outside Kansas will not be available for this study. The one exception is the use of the Air Force Historical

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[23] Meger, 6. Meger references 2005 Joint Publication 1-02, which has a definition for UAV; however, the definition was omitted in amended 2016 version. Also, of note, there is no current published universally accepted definition of RPA.

[24] The reference to balloon warfare in chapter 1 is used to show the development and evolution of the detaching people from danger and using air and distance to attack the enemy.

[25] Laurence R. Newcome, *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles* (Reston, VA: American Institute of Aeronautics and Astronautics, 2004), 1.

[26] Air Land Sea Application Center, *UAS Multi-Service TTPs*, 2. Group 4 and 5 unmanned aircraft refer to a category system that defines UAS by gross takeoff weight, normal operating altitude, and airspeed. For the Air Force, Group 4 consists of the MQ-1B Predator and Group 5 is comprised of the MQ-9 Reaper and RQ-4 Global Hawk.

Research Agency, which is located at Maxwell Air Force Base, Alabama. The author has limited the research question to U.S. unmanned aircraft to focus the scope of the paper. The study of non-U.S. countries' UAS programs provides two complication: First, many countries do not have the history with unmanned aircraft to satisfy the bounds of this paper. Secondly, obtaining documents from countries with UAS programs during the required timeframe proved extremely difficult based on limitations to travel. Therefore, other nations' efforts will only provide context.

The time frame under scrutiny focuses on World War II (1939–1945) through the end of the Vietnam War (1961–1973). The specific time period was selected because of the fledging development occurring during that time and accessibility of research literature. Additionally, this paper will not analyze any classified data. Research on recent conflicts revealed a large proportion of information is still classified. This thesis uses naval UAS concepts because of the resemblance of uses between services as they developed this technology. The focus will be on air forces within the Army and, subsequently, the Air Force. Finally, key components to UAS technology are the ground control stations, simplex and duplex signals, and other capabilities that enabled UAS to fly over long distances. This paper will not address those technologies in detail to focus on aircraft specific development.

Research Design

Primary and secondary sources will aid in the analysis of the U.S. Army and U.S. Air Force's unmanned aircraft from 1939 to 1973 and the major conflicts during that period. Numerous Combined Arms Research Library and Air Force Historical Research Agency resources exist to help supplement ideas and facts about various conflicts and

unmanned systems. Primary source documents will put period events into context. Additionally, primary resources will examine attitudes of contemporary professional officers as reflected in professional journals and archival documents relating to programs. Ultimately, the majority of the references that are used will be secondary and online sources to augment primary sources.

Qualifications

The author is a former B-1 Bomber instructor weapons systems officer who has flown in support of Operations Iraqi Freedom and Enduring Freedom. He is currently a remotely piloted aircraft (RPA) instructor pilot with four years' experience, totaling over 1,200 hours, flying both the MQ-1 Predator and MQ-9 Reaper in multiple theaters of operation. His manned-unmanned aircraft background provided the author with a unique perspective on both communities and the challenges of aviation culture. The author has also worked at the base headquarters staff, which allowed insight into strategic utilization and integration of these systems across multiple theaters, as well as future uses and structures. It could be argued that the author's knowledge and association with the community creates a bias that could influence objectivity; however, it is the operator's insight that allows him to see multiple facets to the operational employment of these systems. The author's background was an important asset in making connections and translating facts, thoughts, feelings, and motivations regarding unmanned aircraft during the various periods into a significant narrative.

Significance of this Study

The subject of unmanned aerial warfare has high visibility within the civilian–political realm and has become a force multiplier for combatant commanders. The demand for UASs proves their eventual survivability, viability, and ubiquity moving into the future. Little is known about the earliest uses of unmanned aircraft that laid the foundation for current capabilities and employment. Through numerous conflicts, the use of unmanned aircraft became more vital as technology improved. The importance of knowing the evolution of these systems and their capabilities can help all services to understand the historical context and criticality of future endeavors such as development, doctrine, operational use, and institutional acceptance.

Chapter 2 explores the literature review of pertinent sources used in this paper. The literature review describes, summarizes, analyzes, evaluates, and clarifies how the sources relate to the topic of this paper. Additionally, the literature review assesses limited number of works that are central or integral to analysis and conclusions.

Chapter 3 examines how the Army used the OQ-2 Radioplane during World War II. In 1941, the OQ-2 was the first mass-produced U.S. UAS and, by 1945, factories in Van Nuys, California, had produced 15,000 of these aircraft as targeting drones. These drones' primary use was for target practice for the Army Air Corps. This chapter will also look at Operation Aphrodite and Project Anvil in 1944, which resulted in one of the most ambitious joint operations of World War II: the use of B-17s and B-24s loaded with explosives in order to strike German laboratories and V-1 "buzz bomb" sites. This chapter also examines the DH-28 Queen Bee, the "drone" program, and the potential missed opportunities to develop the technology further due to financial limitations.

Chapter 4 focuses on the Q-2 Firebee and its use during the Cold War. In 1960, after the downing of Francis Gary Powers in an Air Force U-2 over the Soviet Union, the Eisenhower Administration scrambled to replace the reconnaissance mission with an unmanned capability. The Air Force offered the Firebee as a solution. The Firebee used preprogrammed routes in “denied areas.” The chapter discusses how the operational use of the Firebee and perceived successes shaped attitudes and programs. Additionally, this chapter examines the institution of the first drone group and the ultimate stagnation of UAS programs during times of relative peace.

Chapter 5 assesses how the AQM-34 Lightning Bug (i.e., a modified Firebee) variants were used during Vietnam. They confounded enemy fighters over China, North Korea, and Vietnam, by flying at low altitudes. Research during this era shows an appreciation for the capabilities of unmanned systems and the introduction of the second drone group in the Air Force. The exhaustive use of UASs during Vietnam, particularly for reconnaissance, proved instrumental in pleading the case for future development as the world progressed into the 1980s and 1990s. Chapter 6 concludes the paper, providing summarizing key points relating to innovation throughout the history of unmanned aircraft, future possibilities, and research questions.

CHAPTER 2

LITERATURE REVIEW

The purpose of this literature review is to provide an overarching view of publically available, unclassified material that examines UAS use during pre-21st century conflicts. The intent is to identify any common themes, ideas, theories, and thoughts on the topic in order to demonstrate how this thesis adds to the literature about the unmanned aerial field. The literature review addresses primary and secondary source materials that provide viewpoints on how the systems were used, Air Force culture, the reluctance to adopt UASs, and gaps in development.

Unmanned systems have been popular in recent years because of the advantages of endurance, optics, and precision strikes they provide to U.S. forces. The technology has caught up with cost effectiveness and the demand for these systems continues to increase. Numerous authors have written books about UASs in an effort to capture the intrigue of unmanned aircraft. While there is no scarcity in available literature, what is available is episodic, scattered, and focuses more on the chronological narrative. This thesis seeks to infuse the UAS body of literature with an original thought via a topical discussion in order to not only continue the research of UASs' long history, but also to consider new ways to interpret the information.

This literature review examines the most influential resources for each period this thesis covers, which consists of pre-World War II, World War II, Cold War, and Vietnam. Within each review is analysis on the literature's significance to this thesis. The first significant piece of literature looks at the seeds and earliest developments of unmanned flight, from idea to concept to realized prototype.

Pre-World War II Era Sources

The first resource to discuss is Lieutenant Colonel Richard Clark's paper entitled "Uninhabited Combat Aerial Vehicles: Airpower by the People, for the People, but not with the People" (2000).[27] Clark, an Air University College of Aerospace, Doctrine, Research and Education program attendee, used thorough research to synthesize unmanned combat aerial vehicles (UCAVs) through the lenses of the past, present, and future. The most advantageous aspect of his paper looked at the evolution of UCAVs. He recognized the continuous cycles UCAVs have dealt with and hurdles that contributed to a checkered past. However, his premise was to look at the technology to see what development lessons can be learned from the past in order to avoid the same pitfalls. He also heavily discussed the challenges of unmanned aircraft. Not seen in any other reading was Clark's discussion of the first unmanned aircraft, which was a kite on a string as a downlink to a controller on the ground nearly two thousand years ago. He also discussed military use of kites during the Spanish–American War and the Kettering Bug, both of which are beneficial to this thesis.

The second significant reference is the memoir of Samuel Pierpont Langley and Charles M. Manly entitled *Memoir on Mechanical Flight* (1911).[28] Langley, an inventor and prolific aeronautical innovator, kept exceptionally detailed accounts of his work. The book is broken down into two periods—1887 to 1896, written by primarily by Langley,

[27] Lt. Col. Richard M. Clark, "Uninhabited Combat Aerial Vehicles: Airpower by the People, for the People, but not with the People" (Cadre Paper No. 8, Air University Press, Maxwell Air Force Base, Montgomery, AL, August 2000).

[28] Samuel P. Langley and Charles M. Manly, *Langley Memoir on Mechanical Flight* (Washington, DC: The Smithsonian Institution, 1911).

and 1897 to 1903, written by Manly. Langley did not survive long enough to see the book published, but the memoir provided a wealth of insight into his thoughts and actions as he worked to create various types of aircraft. It outlined his experiments with small models growing into the construction of engines and frames. The benefit of this book is that the reader gets a first-hand understanding of Langley's trials, tribulations, and successes in developing the first-ever unmanned aircraft, which flew from a houseboat. The accomplishment of creating a heavier-than-air, steam-driven object showed promise to the military, causing Langley's attempt to create a larger version for use by the Army and Navy, which was ultimately unsuccessful. The memoir was used for this thesis because of the historical value of understanding the process of an innovator in air exploitation and understanding the beginnings of the rollercoaster of success and failure the aviation community has gone through, as well as the frustrations that accompanied them.

A third reference source was a book written by Laurence Newcome called *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles* (2004).[29] Newcome, a former Air Force B-52 aviator, has worked with multiple unmanned aircraft and understands the strengths and weaknesses of the systems. As an advocate of the technology, Newcome's book was written to educate people on the history of UAS systems. His book is a look at the breadth of unmanned aircraft usage over time, but unlike other references, his work has substantial depth in certain areas. One detailed section of his book discusses the development of the Kettering Bug and the players and fiscal responsibility required to make the concept a reality. This source was selected because of the thorough data Newcome collected and the ties he created in order to learn

[29] Newcome.

how the systems evolved. His work was used to create a cautionary message against reinventing the wheel.

Another important pre-World War II secondary source is a journal article called "A Brief History of Early Unmanned Aircraft" (2013) by John F. Keane and Stephen S. Carr.[30] Written by authors who specialize in writing about missile defense and precision engagement systems, the article looked at unmanned systems in breadth rather than depth by attempting to touch on many eras. One of the strengths is the analysis of pre-World War I development and World War I efforts in using the Kettering Bug. The authors set the political framework and landscape and showed how the system matured under various developers. This resource gave a historical base but also described the competitive challenges between the Army and Navy, which proved important in subsequent decades.

World War II Era Sources

As the thesis progresses into the World War II era, multiple resources were beneficial. The first is P. W. Singer's book *Wired for War* (2009).[31] Singer, the director of the 21st Century Defense Initiative at the Brookings Institution, authored a compelling book that looked at robotic evolution. He investigated robotics in warfare and how technology is reshaping battlefield understanding. While Singer bounces between military and societal trends to illustrate his points, he makes a coherent argument for drone warfare. This book was chosen because Singer used historical examples, such as Operation Aphrodite, and discussed "man in the loop" and societal "autonomy" as

[30] Keane and Carr.

[31] P. W. Singer, *Wired for War: The Robotics Revolution and Conflict in the Twenty-First Century* (New York: Penguin Press, 2009).

philosophical concepts. The book assesses robotics in its totality and not only focuses on UASs' robotics program; however, the book does have great information regarding historical tidbits of UAS knowledge. It also intellectually sets the stage for conversation regarding the evolution of UAS and future implications, which are addressed in Chapter 6 of this thesis.

Dave Sloggett's book *Drone Warfare: The Development of Unmanned Aerial Conflict* (2015)[32] focuses on the development of drone warfare as known today by making connections with the past and pressing into the future. The study focuses heavily on ISR aspects of the systems and highlights Samuel Pierpont Langley's early influence. Sloggett also conducts a masterful review of how Abe Karem rejuvenated the UAS program in the United States in 1977 after multiple difficulties. In addition, he highlights other inventors who had their hands in the development of UASs and looks at other countries, such as the United Kingdom, that developed UAS technology. The book also looks at overarching issues of why America invested in drones and barriers that were surmounted. The World War II information shed light on the necessity for drone use to overcome the V-1 threat.

Major Darin Gaub's monograph "The Children of Aphrodite: The Proliferation and Threat of Unmanned Aerial Systems in the Twenty-First Century" (2011) seeks to correlate the benefits of UASs in current conflicts with demonstrated value in World War II.[33] One of the most compelling arguments Gaub presents is his comparison of similar

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[32] Sloggett.

[33] Maj Darin L. Gaub, "The Children of Aphrodite: The Proliferation and Threat of Unmanned Aerial Systems in the Twenty-First Century" (Monograph, School of Advanced Military Studies, Fort Leavenworth, KS, May 2011).

growth and proliferation of UASs during World War II and the Air Force environment today. The report recognizes the U.S. military's employment of UASs but highlights routine gaps in doctrine, organization, and training with UASs, which affected overall usage of the systems in World War II. Gaub further delves into counter-UAS threat analysis of current state and non-state actors and how the United States must be prepared for those threats. This monograph can be especially important in correlating doctrine and organization during the various conflicts in which UASs have been used.

Cold War Era Sources

Barry Miller's article in *Aviation Week & Space Technology* entitled "USAF Widens Unmanned Aircraft Effort" (1970) discusses the high-altitude Ryan Aeronautical 154 Firefly reconnaissance aircraft that performed long-range photographic missions in Southeast Asia.[34] Miller, a prolific writer on the subject of unmanned aircraft, acknowledges unmanned aircrafts' increasing importance in reconnaissance and as platforms that decrease human risk. Additionally, the article analyzes the ways in which the shooting down of an Air Force U-2 during the Cuban missile crisis proved to be the final catalyst for an increase in the use of unmanned aircraft. Finally, Miller discusses the various Firebee aerial-vehicle versions, along with technological advances and challenges. This article is helpful in laying out development timelines and showing some of the mindsets of the era based on the capabilities UASs provided.

Another good resource is R. Cargill Hall's article "Reconnaissance Drones: Their First Use in the Cold War" (2014), which looks at the jet-powered target drone known as

[34] Barry Miller, "USAF Widens Unmanned Aircraft Effort," *Aviation Week and Space Technology* 7, no. 4 (November 1970).

the “Lightning Bug” and its use to perform long-range aerial reconnaissance.[35] It discusses how technological evolutions increased the drone’s operating ceiling, speed, and programming characteristics. The article also presents attitudes and biases of general officers, primarily fighter pilots, who refused to participate in the unmanned reconnaissance program. Strategic Air Command, the bomber community, seemed more welcoming of the technology because of the capabilities to enable reconnaissance missions. The article concludes by discussing the use of UASs in the 1960s and 1970s and the transformational mindset shift of Air Combat Command toward actively seeking a tactical reconnaissance role, which was beneficial in also showing cultural shifts in the Air Force toward UASs over time.

John Blom’s *Unmanned Aerial Systems: A Historical Perspective* (2010) is a useful secondary source.[36] Blom acutely describes UASs from a historical and current perspective. He provides extremely valuable analysis on unmanned systems during conflicts and in the interwar years. Blom’s book uses an easy-to-read methodology that starts with the historical perspective, then discusses the development of UASs during major conflicts, and finally UASs in the 1990s, Iraq, and Afghanistan, showing the growth of the systems. Even though his paper focuses on UASs within the Army, the information it provides is useful in understanding the Army’s perspective of the remote systems, especially before and early after the separation of the Air Force.

Lieutenant Commander John Trefz’s paper, “From Persistent ISR to Precision

[35] R. Cargill Hall, “Reconnaissance Drones: Their First Use in the Cold War,” *Air Power History* 61, no. 3 (2014).

[36] John D. Blom, *Unmanned Aerial Systems: A Historical Perspective* (Fort Leavenworth, KS: Combat Studies Institute Press, 2010).

Strikes: The Expanding Role of UAVs" (2003), addresses the expanding roles of UASs and their use by operational commanders.[37] The premise was that technological advancements continue to revolutionize capabilities and enhance overall reliability of the systems. The most pertinent aspect of the report is Trefz's research into the history and background of UAS platforms. He briefly looks at the American Civil War and both the Union and Confederate forces' use of balloons as unmanned vehicles loaded with explosives. He also dissects World War II and the use of drones as force multipliers in the ISR realm. Trefz reviewed the stagnation of UASs until intelligence-heavy events spurred their revival, namely the Cuban missile crisis and Vietnam. Ultimately, his paper culminates with more recent conflicts, such as Operations Desert Shield, Desert Storm, and Allied Force.

Vietnam Era Sources

Paul Elder's declassified report entitled "Project CHECO Southeast Asia Report. Buffalo Hunter 1970–1972" (1973) is a valuable primary source. Contemporary Historical Examination of Current Operations reviewed the uses of unmanned aircraft in Operation Buffalo Hunter to thwart counterinsurgency and unconventional warfare in Southeast Asia in the 1970s. [38] He examines how Operation Buffalo Hunter successfully used unmanned-aircraft capability in Vietnam, which allowed ISR to hunt for surface-to-

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[37] LCDR John L. Trefz, *From Persistent ISR to Precision Strikes: The Expanding Role of UAVs* (Newport, RI: Naval War College, 2003).

[38] Paul W. Elder, *Project CHECO Southeast Asia Report. Buffalo Hunter 1970-1972* (Hickam AFB, HI: Pacific Air Forces CHECO Division, 1973), accessed 3 October 2015, http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html &identifier=ADA486697.

air missile systems. Elder illustrates the initial security concerns of the era, but because of operational successes, drones were brought to the forefront of Operation Buffalo Hunter.

In "Air Interdiction in World War II, Korea, and Vietnam: An Interview with Gen. Earle E. Partridge, Gen. Jacob E. Smart, and Gen. John W. Vogt, Jr." (1986), Richard Kohn and Joseph Harahan interviewed three general officers who led operations in World War II, Korea, and Vietnam.[39] The report, based solidly on oral history interviews not far removed from the Vietnam time frame, gives a detailed discussion with General Vogt, who provided a first-hand account of working with drones and accentuated how they could go into areas in which conventional airplanes would not survive. He went on to discuss how he wanted to bring them to Europe, but the Air Force had not fully adopted drones as viable systems. One of the most interesting aspects of the report is the discussion between General Smart and General Vogt regarding future uses and capabilities of drones to illuminate and laser-designate targets for kinetic weapons effects. While still an immature technology in the 1980s, laser designation is a capability that has come to fruition in use with modern-day UASs as designator platforms and is one of their most important tools when supporting ground forces.

Thomas Ehrhard's book "Air Force UAVs: The Secret History" (2010), which is about the secret history of UASs, is a comprehensive look at the systems through time.[40]

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[39] Richard H. Kohn and Joseph P. Harahan, "Air Interdiction in World War II, Korea, and Vietnam: An Interview with Gen. Earle E. Partridge, Gen. Jacob E. Smart, and Gen. John W. Vogt, Jr." (USAF Warrior Studies, Office of Air Force History, Washington, DC, September 1986).

[40] Thomas P. Ehrhard, *Air Force UAVs: The Secret History* (Arlington, VA: Mitchell Institute Press, 2010), accessed 21 September 2015, http://aviationweek.com/site-files/aviationweek.com/files/uploads/2015/05/1970-%20UAVs%20in%20the%20Vietnam%20War.pdf.

The book examines declassified research documents that highlighted the revolutionary breakthroughs in ISR and the exponential growth of UASs. Ehrhard began the book by looking at UASs as national assets but dives into the evolution of multiple variants and the perspectives of senior leaders on UAS use. The book ultimately studies the advanced research concepts involved with drones and the cost and perceived threat aversion to enemy air defenses, which have created an uneven pattern of acceptance in the Air Force over the decades.

All of the sources that are discussed provide foundational research that assists in answering the primary research question of how the U.S. Army Air Corps, U.S. Army Air Force, and U.S. Air Force used unmanned aircraft in major conflicts from World War II (1939–1945) to Vietnam (1961–1973). The resources provide information in scattered fragments in various levels of detail. Additionally, the connection between the primary question and secondary questions is important and are not addressed with the literature.

The secondary questions (i.e., Was there a thread of missed opportunities due to political and budgetary factors that led to the underdevelopment of UAS technology? What were the sentiments of manned aircraft pilots regarding UAS? Was there generalized acceptance of these technologies or was there an internal aversion to a concept that potentially threatened the aviator status quo?) are important and tied to the primary question. The literature fails to make coherent connections regarding these important secondary questions that are nested within the primary. This gap in research makes this thesis important to the overall UAS narrative and understanding.

CHAPTER 3

WORLD WAR II

> In a test that took place several years ago, a small, pilotless plane took off from Cook Field in Dayton, Ohio. A team led by the inventor Charles Kettering had developed the airborne contraption, conceived as a top-secret weapon to deliver explosives against enemy troops. That was 1918, toward the end of World War I. The craft was the first practical unmanned airplane.
>
> — John DeGespari,
> "Look Ma, No Pilot!"

Interwar Years

During the interwar years, the lack of innovation in unmanned aircraft development profoundly affected the evolution of airpower and remote warfare. In the aftermath of World War I, all the major participants found themselves suffering from the trauma of high-attrition warfare. The Treaty of Versailles, signed on 28 June 1919, signified that World War I was over with the return of a quasi-peaceful balance among the Allied and Central powers. The four years of war from 1914 to 1918 took a toll on the people and resources of all countries involved. The financial strain determined military priorities and the fledgling concept of unmanned warfare that had spurred the imagination at the end of World War I did not rank high on the list.

The ramifications of the Treaty of Versailles went beyond the pursuit of reparations for World War I and sought to ensure that the German war machine might never rise again.[41] In some ways, the perceived peace stifled military growth in the areas

[41] Michael S. Neiberg, *Fighting the Great War: A Global History* (Cambridge, MA: Harvard University Press, 2005), 352-359. In Paris during January 1919, the Treaty of Versailles defined the measures of post-war agreement in which the victors sought compensation from the losers. People like George Clemenceau, the French Premier,

of research and development. President Franklin Roosevelt increased government spending in nearly all areas of American, life but reduced defense spending by approximately $221 million from 1932 to 1934. U.S. military strength reduced to sixteenth in the world and the unwillingness to fund defense because of the guise of peace led to less support for spending on what were regarded as unproven systems during that period. [42] The reduction in military strength and defense spending revealed themselves as critical constraints in the period leading up to World War II. The Germans were watching all Allied nations and knew the road to establishing military power once again required development and planning.

In the United States, after a relatively short victory and show of strength in World War I, America found itself on the cusp of the 1920s. Presidents Warren Harding and Calvin Coolidge looked to boost the post-war American economy through a technological boom with inventions such as the automobile, refrigerator, and telephone.

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wanted revenge for French losses and insurance that German military might was decimated. Interested parties achieved this by stripping Germany of its wealth and resources. The President of the United States, Woodrow Wilson, sought a more long-lasting peace rather than revenge. British Prime Minister Lloyd George sought to reestablish Germany as a viable economic trading partner rather than destroying Germany economically. His aims were to avoid mass migrations of refugees, starvation, and poverty, which led to communist ideologies.

[42] Neiberg, 359. The loss of German land was only one aspect that infuriated Germans. The German Army was reduced to 100,000 men, it was not allowed to have an air force or submarines, its battle fleet was surrendered and interred, and it gave up thousands of heavy guns, locomotive railway cars, and submarines to ensure that the armistice was not simply a break in action before resuming the offensive for the Germans. The armistice was an end to the fighting but not a final peace. In addition, the Germans had to take the blame for starting the war and pay reparations to the amount of 132 billion gold marks, or $33 billion. On 28 June 1919, a compromised peace was reached by the Allied nations and Germany, but it was to the dissatisfaction of nearly all other signatories.

The Atlantic and Pacific Oceans provided a buffer from invasion while military leaders in the War Department focused on strategic bombing to limit combat casualties. In most cases, after 1918, the United States, hoping not to be in a conflict anytime soon, realized that the technology of unmanned aircraft was not advanced enough to justify large investments into it.[43]

During the 1920s, the U.S. Army looked into some innovative UAS projects despite limited budgets, in particular, ones that enhanced communications and control. For example, one program, called "Messenger," revolved around an inexpensive aircraft that could deliver messages from headquarters to other locations without requiring runners. An advanced concept of Messenger was the "Messenger Aerial Torpedo," which could fly remotely from one headquarters to another. The system, while innovative, was defunded in 1926 due to technological deficiencies. The research conducted did lead to advancements in radio controls to supplement inertial navigation.[44] However, Nazi Germany's rise as a global military power changed the minimalist military mind set.

In the early 1930s, there was an informal restriction on innovation due to inter-service rivalries fighting for money. As Germany began building its military resources in

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[43] Steven J. Zaloga, *Unmanned Aerial Vehicles: Robotic Air Warfare, 1917-2007* (Oxford: Osprey, 2008), 6. Zaloga mentions that one of the challenges presented to the Army was determining the value of capabilities. On one hand there were UASs designed to return to base, and guided missiles expected to detonate upon impact with their target. While benefits existed for both, the Germans soon showed the devastation cruise missiles could have on the battlefield.

[44] Zaloga, *Unmanned Aerial Vehicles*, 6-7. Dave Slogget's book adds how the MAT, developed by Elmer Sperry, began as a project to carry messages to the commanders in the field. The MAT was designed to be rugged and potentially land in small fields. This version was remotely controlled. One major concern was lag between operator input and MAT reaction, because too short a time lag created instability, resulting in operators over-controlling the aircraft. Slogget, 17-18.

1934, Japan invading Manchuria, and actions in China, U.S. military technology development was slowly being encouraged again due to the looming threats. Unfortunately, the U.S. military stifled some potential innovations due to financial bickering between the Army and the Navy and inside the Army between the Army Air Corps and other branches of that service. This was understandable, due to the constant battle of each service validating its own existence; however, while in the early interwar years, military innovation was hampered by the perception of peace, this time, it was hampered by political demands for budget share.

In 1933, Germany saw the advent of Adolf Hitler as Chancellor, who promised to return Germany to its previous glory. Under his control, Germany started on a path of rapid militarization and re-armament from the negligible naval and military forces allowed it by Versailles. The creation and development of mechanized resources, such as trucks, airplanes, and tanks, provided a new level of speed and reach to warfare, although by 1939 80% of the German Army looked much the same as it had in 1918. The concept of the "blitzkrieg" was becoming an operational concept that was used six years later against Poland. Simplistically, the strengths of the blitzkrieg included the combination of quick troop movements, armored thrusts, use of motorized artillery and infantry, and massive use of airpower in concert with infantry movements.[45] Airpower was becoming ever more important in the planning and practice of mechanized war.

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[45] William J. Fanning Jr., "The Origin of the Term 'Blitzkrieg': Another View," *Journal of Military History* 61, no. 2 (April 1997): 283.

In 1941, the size of the US Army Air Corps was at 152,125 personnel, and it grew to a wartime high of 2.4 million and 80,000 aircraft in 1944.[46] The interwar budgets and resources required maximizing training and effectiveness as priorities, and the Navy always looked for ways to increase its capabilities given that President Franklin Roosevelt regarded it as the primary deterrent for war. Unlike World War I, World War II saw the use of unmanned aircraft as more than mere flying bombs. UAS development branched into their use as targets. This requirement became apparent as the Germans unveiled their V-1 flying bomb, which resulted in a race for unmanned technological supremacy.

Drone Origins

The desire for improved effectiveness from unguided to guided UAS led to the reinvigoration of unmanned technology. On the forefront were the British, who were using remotely piloted aircraft as targets to improve the marksmanship of their naval gunners.[47] In 1933, multiple naval tests with unmanned aircraft revealed the challenges of naval gunfire to destroy airplanes. In America, this notion echoed the sentiments of resigned Colonel Billy Mitchell who, through the latter half of his career, was a strong

[46] James Hart, "Expanding the Size of the U.S. Military in World War II," Warfare History Network, 4 January 2016, accessed 15 February 2016, http://warfarehistorynetwork.com/daily/wwii/expanding-the-size-of-the-u-s-military-in-world-war-ii/.

[47] Sloggett, 19-22. The rapid development of manned aircraft and the threat they could pose to naval vessels drove the Royal Navy to find new ways to train their gunners. UAS proved a valuable tool that did not put Royal Air Force pilots in danger, yet trained gunners for airborne attack.

advocate for airpower and its use to find and destroy ships.[48] The British naval gunnery tested with unmanned aircraft, and Mitchell's tests showed that the capabilities of airpower were critical to the development of UAS during that time. Combined, the tests suggested the viability and value of unmanned systems necessitated investment in development in both countries.

One opportunity presented itself in 1935, when U.S. Admiral William H. Standley, Chief of Naval Operations, on a visit to Britain to attend the London Disarmament Conference, observed a British demonstration of the De Havilland (DH-82B) Queen Bee. The Queen Bee was the Royal Navy's new remote-controlled target aircraft, and based on what he saw of it in action, he recommended that the U.S. Navy follow suit. Standley wanted these targeting aircraft to help train naval gunners by replicating the types of maneuvers attacking aircraft might perform.[49] He charged Lieutenant Commander Delmer Fahrney to develop a similar system. Fahrney used the name drone to pay respect to the Queen Bee, and the name served a dual meaning because it could not operate unless controlled by another "mother" plane or operator on the ground. Fahrney began referring to the aircraft as the drone in his December 1936 status report.[50]

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[48] Newcome, 47.

[49] Sloggett, 22. In his book, Laurence Newcome discusses how Fahrney graduated from Annapolis in 1920 and was a naval aviator. In 1936, and in the next several years, Fahrney ran his radio-control aircraft team from the Naval Research Laboratory's Radio Division. He converted numerous planes to radio-control and flew them in increasingly complex tests and flight regimes. Newcome, 63-64.

[50] Everett, 306. There are two theories of how the term drone came about, the first is described as, "Following discussions with Naval Research Laboratory people in November, all agreed that the Navy radio-control aircraft should be referred to as drone,

Figure 3. DH-82 Queen Bee

Source: Konstantinos Dalamagkidis, Kimon P. Valavanis, and Les A. Piegl, *On Integrating Unmanned Aircraft Systems Into the National Airspace System: Issues, Challenges, Operational Restrictions, Certification, and Automation: Science and Engineering* (Netherlands: Springer, 2013), 15.

Standley gave Fahrney nine requirements for the drone:[51]

1. A radio-controlled seaplane;

2. A speed of at least 100 miles per hour;

3. A ceiling of 10,000 feet;

4. A capability to take off conventionally or be catapulted and land conventionally under radio control;

5. A capability for straight and level flight, normal turns, climbs, glides, and entering and pulling out of dives up to 45 degrees while under radio control;

6. A capability for using the complete range of the throttle under radio control;

7. A minimum control range of 10 miles from the ground control to the plane;

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thus maintaining the connection to the British Queen Bee." The second theory is, "To those who know anything about honeybees, the significance of the term will be clear. The drone has one happy flight and then dies." Today, drone is a general term used synonymously by most people who do not know the history or differences of unmanned aircraft.

[51] Sloggett, 22.

8. Armor not required;

9. Weight of onboard control equipment not to exceed that of a normal crew.[52]

Fahrney began development of the Navy's no live operator aircraft. Once testing was complete using the N2C-2 drone, the program was placed under the Pacific Fleet to provide target practice for gunners onboard the USS *Ranger* (CV-4), which became the first ship to use a target drone in the U.S. Navy. The use of the target drone became commonplace for the Navy by 1939 and revealed deficiencies in training and capabilities. Fahrney understood the potential for this innovative technology and pushed for the development of assault drones.[53] The idea of assault drones was prolific because Fahrney realized a drone, capable of carrying weapons, provided a standoff capability that increased the safety of the fleet, if properly developed. This was the first introduction of the idea of an offensive, reusable UAS.

In late 1941, the Navy's work with the drone was significant for the Army because of the inter-service cooperation efforts happening behind the scenes. For example, Army Air Corps Captain George Vernon Holloman was Fahrney's counterpart and they developed a close working alliance. Holloman was an engineer who had the ear of General Henry "Hap" Arnold, Chief of the Army Air Corps. On numerous occasions, if the Navy cut off specific funding for the target drone program, Holloman procured the equipment needed from Arnold. Holloman's efforts were rewarded as the Army took notice of the target drone's capabilities and reaped the benefits of the naval UAS development concepts and processes. Unfortunately, during discussions and progress,

[52] Newcome, 63.

[53] Ibid., 66.

Pearl Harbor occurred on 7 December, requiring all available aircraft, new and old, be fitted for service.[54] This was another time in the history of UAS that development was hindered due to external forces. At this point, senior military leaders were realizing the potential of UASs, but were unable to bring them to fulfillment.

Weapon of Retaliation

In September 1939, World War II officially began with the German invasion of Poland. The general belief was that tactical airpower could potentially lead to the destruction of major population centers. Some air force leaders of the major powers also believed that strategic airpower might possibly shorten wars and obviate the need for armies and navies.[55] All major European countries were grappling with how to best use airpower in concert with their conventional forces. British opinions of airpower after the Great War were that bombing vital civilian infrastructure could cripple the willpower of the nation and prompt Germany to seek peace.

In 1941, the Nazis invaded the Soviet Union, breaking a non-aggression pact signed in 1939. The invasion of the Soviet Union opened the war on the Eastern European front, which led to tens of millions of Soviet casualties. In the same year, the Japanese bombed Pearl Harbor, Hawaii in an attempt to limit the United States' ability to interfere with its seizure of the rich resources of the Dutch East Indies. The involuntary

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[54] Ibid.

[55] Alan Stephens, "The True Believers: Airpower between the Wars," in *In The War in the Air: 1914-1994*, ed. Alan Stephens (Maxwell Air Force Base, AL: Air University Press, 2001), 63.

entry of the United States into the war continued a surge of recruitment, manpower, and resources that had begun the year before.

The V-1 Cruise Missile

The relative weakness of the Luftwaffe bomber force to conduct strategic bombing in the west against the British led to Adolf Hitler's attraction to the fast, unmanned flying-bomb concept. Hitler was seeking a retaliatory weapon for the numerous bombing raids Germany was taking from the British in March 1942. In 1939, Argus Motor Works in Germany proposed a large radio-controlled drone called the *Ferfeuer*, meaning "Deep Fire." This aircraft was capable of remote flight from another aircraft of the same type, but the remote-controlled craft carried a one-ton bomb load. The uniqueness of this aircraft was that after delivering the weapon, it was capable of returning to base.[56] This was a shift from the Kettering Bug concept of World War I from single- to multi-use. Ultimately, the Luftwaffe did not show interest in the *Ferfeuer*. The research laid the groundwork for the development of an extremely deadly weapon, the *Flakzielgerat 76* or FZG-76, also known as the V-1 cruise missile.[57] The term V-1 originated from the German propaganda machine, which used the term during radio broadcasts. V-1 stood for *Vergeltungswaffe-1,* which means "Retaliation Weapon 1."[58]

The German V-1 system came as a shock to the Allied powers and spurred aeronautical innovation in the United States. The long-range capabilities of the cruise

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[56] Zaloga, *Unmanned Aerial Vehicles,* 7.

[57] Ibid.

[58] Steven J. Zaloga, *V-1 Flying Bomb, 1942-52: Hitler's Infamous 'Doodlebug'* (Oxford: Osprey, 2005), 9.

missiles left the Allied forces with a demand for different capabilities to combat the threat. In order to counter these German inventions, the Americans sought new methods of unmanned aerial warfare with limited success. These methods demonstrated the risk the United States was willing to take in order to defeat its enemy. The scramble to match unmanned technology highlighted some of the missed opportunities during the interwar years and how war bred innovation.

In order to counter the V-1 campaign, the English fed false information to the Germans about damages in order to ease the effect of the bombardment. Additionally, in an important tactic that influenced unmanned aircraft use, the British defense focused on anti-aircraft artillery along the V-1 approach routes. Due to the limited range of the V-1 and the successful Allied targeting of launcher sites, they became ineffective; however, the V-1 gave rise to a new threat.[59]

[59] Zaloga, *V-1 Flying Bomb*, 19. During the second phase of launches starting on 15 June 1944 and continuing until the end of month, no fewer than 2,442 V-1s were launched at London, with approximately one-third hitting their targets in and around London. The unique and growing roar of the pulse-jet engine led the inhabitants of England and London to nickname it the "buzz bomb." The weapon was indiscriminate and only went silent just before impact. Counter measures to the V-1 resulted in British Gloster-Meteor F1 turbojet fighters and Spitfire Mark 14s shooting them down.

Figure 4. German V-1 Flying Bomb

Source: Ian Poll, "The Evolving Capability of UAV Systems," *NATOs Nations and Partners for Peace* 52, no. 2 (June 2007): 132.

The V-2 Cruise Missile and Operation Crossbow

The V-2 project, also known as the A4 by official designation, gave rise to the modern-day rocket age and was Germany's most expensive military program. On 3 October 1942, the first successful V-2 launch took place and traveled out to sea, covering 120 miles. As development continued, V-2s became more mechanically reliable and precise, and Hitler saw them as a possible operational asset. In July 1943, Hitler committed the German industry to develop no less than 900 V-2 rockets monthly. The systems, such as propulsion, guidance, gyroscopics, and other key components, had to be subcontracted to other, specialized businesses and then assembled in one location for the final product.

Operation Crossbow was the code name of the campaign of Anglo-American operations against German long-range weapons, including the V-1 and V-2. The Allied forces called the long-range V-1 and V-2 threats "Diver."[60] These operations focused on

[60] Zaloga, *V-1 Flying Bomb*, 18.

research and development, manufacturing, transportation, and launching sites, as well as the missiles in flight. Out of fear of the capabilities of the V-1 and V-2 systems, enemy anti-aircraft artillery, and fighter aircraft, the United States grew ever reliant on innovative solutions to minimize risk to aircrews, while maintaining airpower effectiveness.

The OQ-2 Radioplane

Reginald Denny—inventor and entrepreneur—became interested in the military use of unmanned aircraft after successful sales of his toy remote-controlled plane.[61] The Army showed interest and in 1938, the Artillery Branch wanted an exhibition of his advanced versions of remote-controlled aircraft. After a successful demonstration, the Army contracted Denny to produce the Radioplane-4 (RP-4), which was later given the Army redesignation, the OQ-1. [62] Initial purchases were minimal until the attack on Pearl Harbor on 7 December 1941. Subsequently, the United States produced more than 15,000 OQ-2 Radioplanes, making it the first mass-produced unmanned aircraft in history.[63]

Powered by a six horsepower, two-cylinder, two-cycle engine, the OQ-2 took off from a conventional runway, stayed aloft for 70 minutes, and recovered using a runway or parachute. The aircraft was guided by a radio control system, had a maximum

[61] Denny had served in the British Royal Flying Corps in World War I and moved to the United States to pursue his acting career and interest in radio-controlled model airplanes.

[62] Blom, 47. Denny first approached the Army about a remote-controlled plane in 1935 but it failed to gain any traction. In 1938, some interest surfaced from the Artillery Branch requesting a demonstration from his models. Impressed by the capabilities of the unmanned aircraft, the Army signed Denny to a contract to produce better variations.

[63] Singer, 49.

operating altitude of 8,000 feet AGL, and a maximum speed of 85 miles per hour. The OQ-2 was designed to draw the antiaircraft fire of enemy forces, saturate an enemy's air defenses, and improve friendly fire's accuracy as a target.[64]

The work of Denney, as well as the military's interest in such technology, revealed the influence civilian manufacturers had on unmanned technology and progress. Particularly true during budgetary reductions, the civilian industrial capacity and capitalism process highlighted an often untapped resource by military leaders. In this case, Denny was able to show the military how his product could enhance their "flying target" combat capabilities.[65]

Throughout World War II, Denny and his team made numerous variants to the aircraft, increasing its capabilities and evolving it to meet service needs. Denny sold the Army and Navy 50 OQ-1s, 5,822 OQ-3s, and 2,084 OQ-4s. The technological improvements and mechanical enhancements went from an OQ-2 powered by a 6.5 horsepower engine capable of flight up to 85 miles per hour to an OQ-14 with 14 horsepower and flight speeds of up to 140 miles per hour. The drone's missions continued through post-war, until the OQ-19 was used as the first reconnaissance drone.[66]

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[64] Sloggett, 22.

[65] Singer, 50. The construction of the OQ-2 Radioplane required Denny to move manufacturing to Van Nuys Airport, California. Army photographer David Conover was sent by Captain Ronald Reagan (future president) to photograph women supporting the war effort at the OQ-2 facility. As he took photos, he saw a beautiful woman spraying the planes with fire retardant. Conover sent the pictures he took of the woman, Norma Jeane Dougherty, to a friend at a modeling agency. Soon after, the woman dyed her hair from brunette to blond and changed her name to Marilyn Monroe.

[66] Newcome, 59. The OQ-19 Shelduck target drone was outfitted with film cameras to do reconnaissance. This is perhaps the greatest legacy of the Radioplane family of aircraft, being the predecessors for current ISR roles for UAS.

Radio Controlled Target Detachment

On 5 November 1943, an OQ-2 detachment consisting of one officer and seven enlisted soldiers was assigned to the Headquarters, European Theater of Operations, U.S. Army and attached to the Service of Supply of European Theater of Operations. The detachment was entirely self-sustaining and performed its own administration and supply functions. The unit officially began operating and flying on 10 April 1944. The purpose for the detachment was OQ-2 training and protecting London by flying the unmanned aircraft in the same paths as the German V-1s and getting Army artillery to practice its marksmanship.[67]

Training of the OQ-2 Radioplane crews required approximately two weeks dependent on weather conditions. The requirements for the selected detachment crew members consisted of:

> 1. Pilot (rank Captain)–this officer was the pilot and in charge of the Radio Airplane Target Unit. He had to be mechanically inclined with a working knowledge of aircraft flight, maintenance, and some knowledge of radio and electricity.
>
> 2. Crew Chief/Co-Pilot–this individual was the assistant pilot and aided the officer in his duties. He was also the senior non-commissioned officer (NCO) of the crew. His skills required a working knowledge of mechanics, radio or rigging, or, all three.
>
> 3. Two Radiomen–one required knowledge in radio transmitters and the other with building and repairing receivers.

[67] Capt Wheeler B. Bowen, Letter. Radio Controlled Target Detachment, United States Army, Box 539.902A (February-June 1945)–540.01 (16 October 1943-8 January 1944), File 539.9061 (5 November 1943–5 October 1945), Air Force Historical Research Agency, Maxwell Air Force Base, AL. The detachment did a great deal of cooperation with the United Kingdom and the Queen Bee operators in order to stop the V-1 threat. V-1s were being launched against England at the time. The detachment went by motor vehicle, with a set of equipment, to the range at Aberporth.

4. Two mechanics–these personnel required mechanical ability dealing with light welding and internal combustion engines.

5. Two Riggers (Parachute Men)–these individuals required the qualifications of packing parachutes and making minor repairs. Prior experience in building and flying model airplanes was emphasized.[68]

The training with the OQ-2, ultimately, proved to be beneficial for U.S. and British artillery forces. The artillery units used 90-millimeter and fifty caliber machine guns to fire at the drone targets during this phase. The detachment was paired with an anti-aircraft artillery crew tasked to protect certain V-1 avenues of approach. The unit was deactivated on 5 October 1945.[69]

Operation Aphrodite–Project Anvil

In 1944, the Army and Navy conducted two experiments: Operation Aphrodite and Project Anvil, respectively. Both efforts constituted the Allied effort to eliminate the threat of long-range German missiles. Initiated by General Carl "Tooey" Spaatz, Commander of US Strategic Air Forces in Europe, Operation Aphrodite rigged old B-17s, otherwise known as "Flying Fortresses," with inventive modifications.[70] These modifications allowed for a two-man crew—a pilot and flight engineer—who took off

[68] Bowen. Of note, it was recommended that all the members of the detachment had to be volunteers. Additionally, duties were not set in stone. The emphasis was to ensure the team was trained and cohesive so the officer-in-charge could shift people as necessary to ensure that happened.

[69] Bowen. The accomplishments of the detachment included one Bronze Star Medal for meritorious service in connection with military operations and all members received Bronze Service Stars for European Theater Operations ribbons for providing artillery OQ-2 support at the Ardennes and Battle of Rhineland.

[70] Albert L. Weeks, "In Operation Aphrodite, Explosive-Laden Aircraft Were to Be Flown Against German Targets," *World War II* (May 2000): 66.

loaded with 25,000 pounds of explosives, the largest nonnuclear payload in history.[71] As they flew toward V-1 sites in France, the crew headed towards the target at 2,000 feet AGL, initiated a shallow dive, switched control to the trailing B-17 “mothership,” armed the explosives, and bailed out of the aircraft.[72] This also ushered in history’s first unmanned versus unmanned aircraft warfare.[73]

The B-17s, once refashioned for unmanned capabilities and known as a BQ-7, were controlled via remote controls from another B-17 mothership nearby. The BQ-7 was intended to mirror the trajectory of a falling bomb so the controls within the mothership only commanded: left turn, right turn, and crash dive. Through the use of two cameras mounted in the BQ-7’s cockpit, the plan was for the mothership crew to fly the unmanned aircraft into targets well-protected from enemy threats.[74]

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[71] Blom, 48.

[72] Everett, 357. The bailout process was complicated and dangerous. Crews had to jump from the aircraft into the 180-knot slipstream, which was very dangerous at low altitudes. Additionally, the crews had to use the navigator’s hatch because the normal bailout exit was inaccessible due to all the boxes of explosives.

[73] Instructions to Pilots, 471.6 Aphrodite Project CT, Box 520.431B (August-November 1944 v.2)–520.4501A (6 June-16 November 1944), File 520.431B v.2, August-November 1944, Air Force Historical Research Agency, Maxwell Air Force Base, AL. To arm the payload, the pilots accomplished the following checklist before departing the aircraft. When you are ready to leave the ship, do the following things: (1) Pull the mechanical arming wire until it stops, (2) Close the master switch on the special panel (i.e. put the handle up), (3) If a light lights up on the panel, forget the electric system. (4) If a light does not light up on the panel, remove safety plug and push operative plug into socket.

[74] Singer, 48.

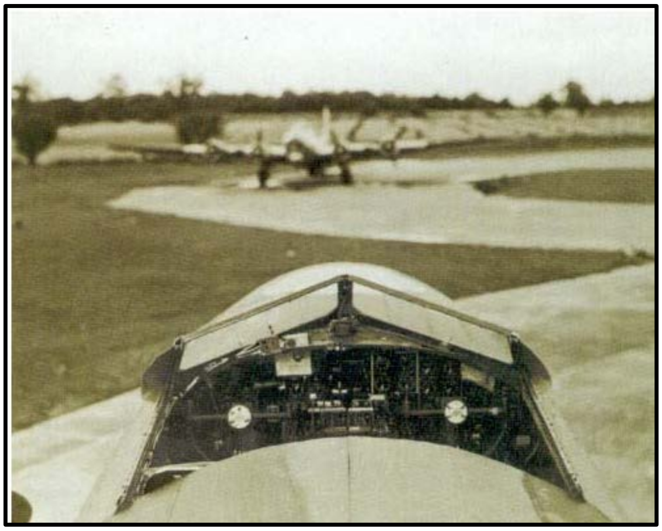

Figure 5. B-17 Drone (BQ-7) Cockpit

Source: Albert L. Weeks, "In Operation Aphrodite, Explosive-Laden Aircraft Were to Be Flown Against German Targets," *World War II* (May 2000): 66. Note: The cockpit of the BQ-7 provided a quick exit for the crew in order to bailout after the explosives were armed

Two axon receivers were preset on different frequencies, one for azimuth and one for pitch control. One radio altimeter was used to reach and maintain any desired, preset minimum altitude. Smoke-generating systems indicated the flight path of the aircraft. The motherships had two axon transmitters, two control boxes, and necessary antenna.[75] The explosive payload was either Torpex or nitro-starch and contained in blocks, packed in wooden boxes, and stacked in the nose, bomb bay, and radio compartment. [76] Torpex was

[75] Aphrodite Mission No. Five, 388th BG Intelligence Report, Box 520.431B (August-November 1944)–520.4501 (6 June-16 November 1944). File 520.431B, 17 August 1944, Air Force Historical Research Agency, Maxwell Air Force Base, AL.

[76] Ira Eaker and Carl Spaatz, Letter, Preliminary Details of Williamson Project per request URAD CS 777 IE July 7, Norstad, Lauris: Papers, 1930-87, Box no. 7, 11 July 1944, Dwight D. Eisenhower Library and Museum, Abilene, KS.

used because it was 1.7 times as effective as TNT. The disadvantages to Torpex was occasional instability. Nitro-starch was considered more stable than Torpex, equal to TNT in explosive power, and was readily available. The downside to nitro-starch was its susceptibility to heat and instability around electrical circuits.[77]

The US Army Air Force experimented with different variants, which could either fly into a target or carry two 2,000-pound GB-4 bombs. The second type could fly over targets like U-boats and drop both weapons. Employment envelopes varied, but a typical release happened at 17,000 feet and approximately 25 miles from the target to allow for ballistic fall of the bomb.[78]

The BQ-7 concept proved to be unsuccessful. The first aircraft failed to reach the target due to flight-control surface issues, and German anti-aircraft batteries shot down the second. The next two attempts were sent over the English Channel but did not reach desired targets, and six others suffered mishaps. In some cases, some BQ-7s flew toward their target then suddenly turned around halfway across the English Channel back toward England. Finally, some were destroyed either intentionally, due to lack of control, or accidentally, by friendly fire.[79]

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[77] Lt H. P. Lyon, 471.6 Aphrodite Project CT, Box 520.431B (August-November 1944 v.2)–520.4501A (6 June-16 November 1944), File 520.431B v.2, August-November 1944, Air Force Historical Research Agency, Maxwell Air Force Base, AL.

[78] Aphrodite Mission No. Five.

[79] Weeks, 66.

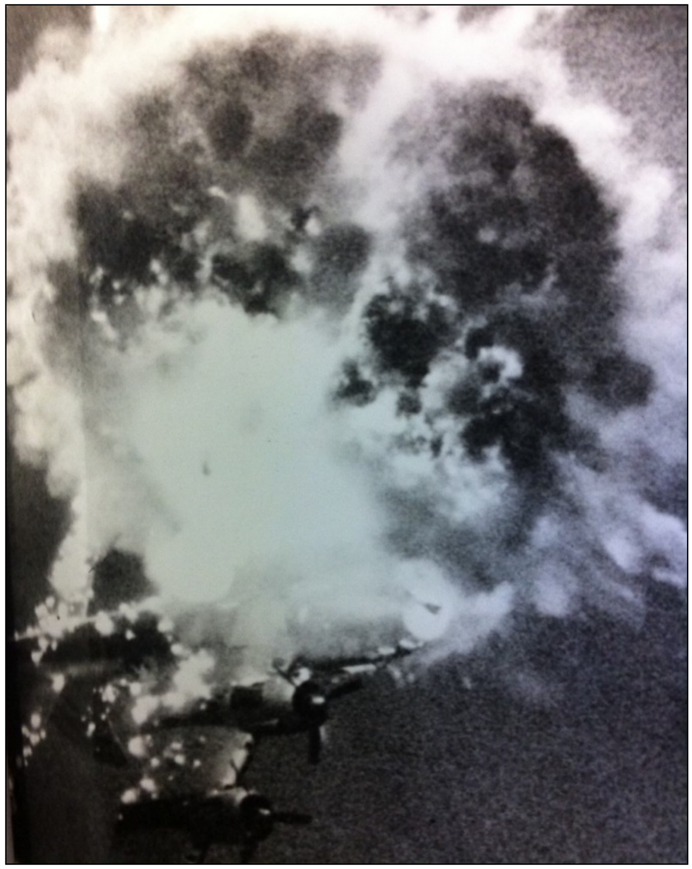

Figure 6. BQ-7 Drone Exploding from Anti-aircraft Artillery Rounds

Source: Wayne Hammack, Unit History of the 3205th Drone Group: Jan 54 through Jun 54, Box K-GP-TEST-3205-HI (January-June 1954)–KP-GP-TEST-3205-HI (January-June 1955), File K-GP-TET-3205-HI (Drone), January-June 1954, Air Force Historical Research Agency, Maxwell Air Force Base, AL.

The Navy pursued its own version of this technology using B-24 Liberators, dubbed BQ-8s under Project Anvil. In Europe, Special Air Unit 1 loaded the B-24s with 24,000 pounds of explosives and aimed them at hardened German targets.[80] Early in the program, pilots Lieutenant Wilford J. Wiley and Joseph P. Kennedy were tasked to destroy a rumored V-3 site, armed with an experimental, 300-foot long "supercannon"

[80] Newcome, 69.

that could strike London from 100 miles away. The two embarked on the mission but before the aircraft made it past the English Channel, the explosives prematurely detonated, killing both pilots.[81] Project Anvil was terminated after 12 other failures; however, the BQ-8 program was slightly more successful than the BQ-7 in that it managed to damage a German submarine pen.[82] Joseph Kennedy's death in 1944 helped end the U.S. military's drone program, not the least being due to the anger of former Ambassador Joseph Kennedy Sr. This shows how the UAS program was set back due to the alienation of a high profile political figure in the Roosevelt Administration.[83]

A little over 25 years earlier, airplanes had first taken to the skies in the first air-to-air conflicts. During World War II, the military saw the first conceptualization of unmanned-on-unmanned technological warfare with Operation Aphrodite and Project Anvil. While larger-scale conflicts between these technologies did not come to fruition, they paved the way for ideas and possibilities about how these systems could be used to attack over long distances.

Despite the developments in unmanned technology during World War II, such aircraft had little operational effectiveness during the conflict. The Army and Navy saw the immediate benefits of the unmanned systems for target practice. However, during the

[81] Singer, 48.

[82] Blom, 48.

[83] According to Singer, up to the time of the incident, Joseph Kennedy was being groomed for greatness by his father, the affluent businessman and politician Joseph Kennedy, Sr. Joseph Sr. was optimistic for his naval officer son. His other son, John F. Kennedy, was far more bookish and did not hold the mantle of succession. The two brothers were extremely different, and the death of Joseph Jr. led to the rise of John within the realm of political influence, and ultimately, to the presidency of the United States. Singer, 49.

interwar years and World War II, there were numerous examples of failed efforts and missed opportunities in developing unmanned technology that might have been beneficial for future conflicts. In today's parlance, people might say that the technology had not "matured" to a point of operational utility yet.

CHAPTER 4

AIR FORCE UAS DEVELOPMENT DURING THE COLD WAR

If you can get mechanical machines to do this, you are saving lives at the outset.
— General Henry "Hap" Arnold, quoted in Thomas P. Erhard
Air Force UAVs: The Secret War

The Second World War's abrupt end with the use of two atomic bombs on the Japanese cities of Hiroshima and Nagasaki pulled back the curtain to a new and destructive way of war.[84] Despite the Japanese surrendering aboard the battleship USS *Missouri*, many Americans questioned how much longer the United States would sacrifice lives and resources for overseas wars. The Soviet Union had emerged victorious against Germany, but at a cost of nearly 25 million Soviet military and civilian lives.[85] The major world powers were once again being required to pick up the pieces of large-scale conflicts. The aftermath, however, led to the uneasy time in American history known as "the Cold War," a time during which the United States and the Soviet Union directly competed for hegemony. The power struggle formed on many fronts including: the political, economic, military, and even technological. However, the sentiment of lives being put at risk echoed throughout the Cold War period.

In the United States, the new president, Harry Truman, hoped for some type of peace with the Soviet Union. He offered to extend the Marshall Plan, which gave supplies

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[84] Peter Paret, Gordon Alexander Craig, and Felix Gilbert, eds., *Makers of Modern Strategy: From Machiavelli to the Nuclear Age* (Princeton, NJ: Princeton University Press, 1986), 779.

[85] Geoffrey Parker, ed., *The Cambridge Illustrated History of Warfare: The Triumph of the West* (Cambridge, UK: Cambridge University Press, 1995), 340-341.

and aid to European nations as a show of goodwill, modernization, and economic prosperity. The Soviets refused, since they viewed the plan as a sign of weakness and prying by the Americans.[86]

Militarily, the United States had expanded at exponential rates to deal with the German and Japanese threats. Although the military created bases and facilities at an expeditious rate during World War II, the military found itself questioning the appropriate peacetime force structure and fiscal basis. Arnold commanded the Army Air Forces with proven and experienced officers under his lead, such as Generals Carl "Tooey" Spaatz, Ira Eaker, Lauris Norstad, and Hoyt Vandenberg.[87]

The Army Air Forces established a postwar goal of expanding to 550,000 personnel, 70 groups of varying aircraft types, 27 Air National Guard groups, and 34 reserve groups. The Army had a limited budget so growth in the AAF meant sacrifices in other ground unit capabilities. According to one airpower historian, the goal of 70 groups was appropriate for peacetime but woefully inadequate for a time of war. The number was decided based on what was essential for global demands and in preparation for the next war. Postwar demobilization after the Japanese surrender restricted military budgets and, ultimately, technological development including in what eventually became the U.S. Air Force.[88]

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[86] Parker, 341.

[87] Walter J. Boyne, *Beyond the Wild Blue: A History of the United States Air Force, 1947-2007*, 2nd ed. (New York: Thomas Dunne Books/St. Martin, 2007), 24.

[88] Ibid., 26.

Fiscal challenges have reverberated throughout U.S. military history, not just that of the U.S. Air Force. The reduction in military funding during interwar periods has routinely led to the inability to fully harness technological advancements. The capability requirements are not as pronounced during peacetime, but during conventional peer or near-peer enemy conflicts, the lack in systems development becomes painfully obvious.

The highest levels of government held discussions about an independent Air Force; the Navy, in particular—which sought continued fiscal relevance—did not want a separate service for airpower. In 1945, President Truman stated: "Airpower has been developed to a point where its responsibilities are equal to those of land and sea power, and its contribution to our strategic planning is great. Parity for airpower can be achieved in one department or in three, but not two. As between one department and three, the former is infinitely more preferred."[89]

The Declaration of Policy of the National Security Act of 1947 provided for the establishment of the Air Force as a separate and distinct branch of the military. Its creation provided consistent oversight and authorities for Air Force leadership, starting on the official creation date of 18 September 1947. W. Stuart Symington was the first secretary of the Air Force, and the first chief of staff was General Spaatz. Agreements between the Air Force and Army, such as the Joint Army and Air Force Adjustment Regulation 5-10-1, dictated that the Army could operate fixed-wing aircraft of less than 2,500 pounds and rotary aircraft weighing less than 4,000 pounds.[90] The Air Force branching off into a separate service was important for many reasons relating to

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[89] Boyne, 30.

[90] Blom, 22.

unmanned aircraft development. Not only did it provide advocacy and an independent financial pot to pull from but it also added an avenue for continued work in UAS technology. This proved especially true now that there was a branch of the service whose sole purpose was to find ways to create and maintain air superiority.

In 1948, President Truman and Secretary of Defense James Forrestal gave the Air Force responsibility for providing "close combat and logistical support to the Army, to include airlift, support, resupply of airborne operations, aerial photography, tactical reconnaissance, and interdiction of enemy land power and communication."[91] Unmanned aircraft in the late 1940s into the early 1950s had transformed from quasi-cruise missiles to target decoys, with the possibility for aerial reconnaissance. Aerial reconnaissance, first seen in World War I at conflicts such as the first Battle at the Marne and the Battle of the Somme, proved its capacity to develop target sets and intelligence to manipulate the battlefield. To create appropriate reconnaissance drones, their navigational accuracy needed to be enhanced and the aircraft that carried the surveillance payloads needed to be reusable.[92]

Rise of the Drone Group

A little-known piece of military history involves the existence of the 3205th Drone Group. The unit's mission was to provide drone aircraft as targets for all branches of the military. Established on 1 June 1951, the group grew to be comprised of six subordinate squadrons, the 3205th Drone Squadron, the 3205th Maintenance and Supply

[91] Blom, 22.

[92] Newcome, 1.

Squadron, the 3215th Drone Squadron, and the 3205th Air Base Squadron were all located at Duke Field (Auxiliary No. 3), Eglin Air Force Base, Florida. The 3225th Drone Squadron was located at Holloman Air Force Base, New Mexico, and the 3235th Drone Group was located at Point Mugu, California.[93]

The 3205th Drone Group flew a mixture of QB-17 drones called "Roughnecks" and QF-80 drones. It maintained approximately 60 QB-17s and six QF-80 aircraft. The letter "Q" designated the unmanned versions of aircraft. Although the group's flying-hour program authorized 8,700 hours of flight time every six months, the unit sometimes went upward of 8,910 hours. One of the unit's major issues was maintenance and the procurement of parts. Aircraft availability rates hovered around 77 percent due to the failure to acquire appropriate parts on time.[94]

Basic QB-17 operations required four pilots: the airborne remote control or "beeper" pilot; his chauffeur, the director pilot; and two ground control pilots, known as a "rudder" controller and an "elevator" controller. Additionally, each mission consisted of 15 additional pilots and 18 enlisted professionals as support, and two pilot controllers for the radar control station to ensure safety and accuracy. In essence, one unmanned mission required four pilots and 33 support personnel for support.[95] The notion of the time was

[93] Wayne Hammack, Unit History of the 3205th Drone Group: Jan 54 through Jun 54, Box K-GP-TEST-3205-HI (January-June 1954)–KP-GP-TEST-3205-HI (January-June 1955), File K-GP-TET-3205-HI (Drone), January-June 1954: 1, Air Force Historical Research Agency, Maxwell Air Force Base, AL. While the day of inception was 1 June 1951, the unit was originally called the 3200th Drone Group until 1 December 1951 when it was redesignated the 3205th Drone Group.

[94] Ibid.

[95] Lt. Col. Walter C. Cannon, Briefing, USAF Drone Program Operations, 10 June 1954, Box K-GP-TEST-3205-HI (January-June 1954)–KP-GP-TEST-3205-HI

that "pilotless" aircraft produced manpower savings, yet in most cases, they were more manpower intensive than manned aircraft.

Manning levels for the 3205th Drone Group fluctuated based on standard manpower rotations but routinely were not filled to authorized requirements. On 30 June 1954, the group had 144 officers authorized to 127 assigned (88 percent) and 1,003 enlisted airmen authorized to 1,070 assigned (94 percent). While the overall officer manning appeared sufficient, qualified QB-17 drone pilot manpower hovered as low as 77 percent.[96] The 11-percent drop revealed the unique training requirements and time necessary to qualify the drone pilots.

Finally, another important note about the squadron was the morale of its airmen, which was not tied directly to operations as many, particularly the enlisted cadre, saw value in their work. However, morale was poor for the first enlistees, who were so discontent with service life that few planned to reenlist. The cause of their unhappiness came from the perceived poor locations, lack of amenities on base, and poor infrastructure in the cities in which they lived. Leadership attempted to boost morale and well-being by building new barracks and more activity facilities but, in the end, most airmen disliked Duke Field for social situations.[97]

(January-June 1955), File K-GP-TET-3205-HI (Drone), January-June 1954, Air Force Historical Research Agency, Maxwell Air Force Base, AL.

[96] Hammack.

[97] Ibid. Of note, this mirrors the challenges of remotely piloted aircraft operators in the 21st-century. Maj Bishane Whitmore, in his capacity working for the wing headquarters at Creech Air Force Base, the hub of RPA operations in 2014, took a survey showing 70 percent of first-term officers were planning on getting out of the military because of conditions. Their main reasons were location, amenities, and lack of occupational growth opportunities. The same types of issues were seen in the mid-1950s.

Figure 7. A QB-17 Executing a Remote Landing

Source: Wayne Hammack, Unit History of the 3205th Drone Group: Jan 54 through Jun 54, Box K-GP-TEST-3205-HI (January-June 1954)–KP-GP-TEST-3205-HI (January-June 1955), File K-GP-TET-3205-HI (Drone), January-June 1954, Air Force Historical Research Agency, Maxwell Air Force Base, AL. Note: The rudder controller in the foreground guides the plane over the middle of the runway. The binoculars are needed to watch the drone as it is braked to a full stop further down the runway.

Figure 8. A Pair of Jets, One of which is a Drone, Wait for Takeoff

Source: Wayne Hammack, Unit History of the 3205th Drone Group: Jan 54 through Jun 54, Box K-GP-TEST-3205-HI (January-June 1954)–KP-GP-TEST-3205-HI (January-June 1955), File K-GP-TET-3205-HI (Drone), January-June 1954, Air Force Historical Research Agency, Maxwell Air Force Base, AL. Note: The pilotless QF-80 in the foreground will be flown off the runway by a remote control station at the side of the runway. In the picture is the elevator controller and not seen is a rudder controller who operates a similar control box that keeps the aircraft lined up with the center of the runway. The director aircraft (background) will assume control during the climb out of the pattern

The Cold War

The concern of nuclear warfare during the Cold War created a need for military preparation. As long as an exchange of nuclear weapons was possible, the requirement for aircraft to be flown into the residual radiation existed. In 1946, manned flight tests proved that radiation sickness was unavoidable, despite the pilots wearing lead-lined flight suits and aircraft being washed upon landing. The Air Force looked to unmanned technology as a safety measure to eliminate risk to personnel. The Air Force sought to

keep people safe from the radiological threat by reinvigorating the rudimentary successes of radio-controlled QB-17s.[98]

During the 1950s, the necessity of limiting the scale of war required the United States to use weapons for desired and scaled effects, rather than for annihilation. Atomic weapons became less of an advantage and more of a shield, as conventional rearmament became a priority. The issue with conventional weapons was cost, and senior leaders were looking for systems that provided more "bang for the buck."[99] To be successful, the Air Force had to stay creative and enhance its tactical and operational effectiveness through reconnaissance.

Of all of the branches, the Air Force's work with UAS technology had the most lasting effects during the Cold War. Multiple types of UASs were introduced with differing focuses. McDonnel Douglas built one design, called the GAM-72 Quail, as a decoy drone in 1961. The Quail was launched from a B-52, was jet powered, and was intended to confuse the Soviet integrated air defense system.[100] As Soviet Surface-to-Air Missile (SAM) systems advanced, the goal of the Quail was to saturate the integrated air defense system to increase the survivability of the ingressive bomber force. At the peak

[98] Newcome, 71. Residual radiation was a concern for aircrew. Some U.S. pilots flew data-gathering missions over Bikini Atoll in the Pacific immediately after the nuclear tests in 1946. The radiation effects revealed the "dirty" aspects of nuclear weapons and the dire need for unmanned options.

[99] Paret et al., 738-740. The NSC-68 was a key document during the 1950s that recognized the advantage that the hydrogen bomb provided; however, this advantage diminished as the Soviets developed their own nuclear weapons. The document discussed that the main option for the president was to build combat capability and conventional forces.

[100] Zaloga, *Unmanned Aerial Vehicles*, 11.

of its inventory, the Air Force had 492 Quails but they steadily became obsolete as Soviet radar technology increased to a point that it could easily identify the differences between decoys and actual bombers.[101]

Compared to decoys, drones were a longer-lasting and viable option as reconnaissance platforms. In 1948, Ryan Aeronautical Company developed a target drone called the Q-2 “Firebee.” The refocusing of the drone’s mission from target drone to reconnaissance drone took nearly 10 years. In 1958, Ryan Aeronautical Company developed the Q-2C Firebee, which was the first drone developed specifically for reconnaissance missions. The Firebee’s J69-T-19 turbojet engine enabled an operating ceiling of 60,000 feet and a range of 800 miles.[102]

The threat of the Cold War piqued interest and the development of a more capable Firebee. The United States focused on reaching deeper into the heartland of the Soviet Union to gather intelligence on its military strength and atomic weapons development. More than one issue arose from those criteria. First, the Firebee required a range of nearly 2,000 miles to reach the heartland of the Soviet Union.[103] The second issue was the radar signature of the Firebee. Since these unmanned aircraft were developed as decoys, the radar signature was intentionally large to ensure radar acquisition by the Soviets. Now that the Firebee’s mission was changing to reconnaissance, the radar signature was a liability. The developers of the Firebee reduced the signature by adding radar-absorbing

[101] Sloggett, 74-75.

[102] Blom, 55.

[103] Blom, 55-56. The Firebee needed a new engine and increased fuel capacity to increase the range by 1,200 miles. Additionally, the wings needed to be larger to support those improvements.

material to the sides of the aircraft, changing the intake, and using non-conductive aircraft nose paint. This initial investment into the Firebee's reconnaissance capabilities proved beneficial; however, as the Cold War continued the Air Force saw a rollercoaster of advancement and obstruction that caused fragmented development progression.

Major "Powers" Face-Off–The Cold War Heats Up

The Air Force, for the most part, lost interest in unmanned aviation technology after the Korean War. Demand for reconnaissance, on the other hand, was at an all-time high due to the fear of Soviet nuclear development. The concern for the Soviets' new capability spurred the development of the U-2 high-altitude reconnaissance aircraft. Starting on 4 July 1954, the U-2, piloted by the Central Intelligence Agency (CIA), gave the United States the capability to fly over Soviet airspace with impunity. Soviet displeasure led to the country's development of the SA-2 radar-guided SAM.[104] The Air Force realized the risk of U-2 operations, and the Air Staff reconnaissance chief inquired about the Q-2C Firebee drone as a possible reconnaissance replacement if needed. By mid-April 1960, the Air Staff was pushing a strategic drone project that led to greater interest in unmanned technology.[105] The UAS resurgence began on 1 May 1960, when the Soviet Union shot down an American U-2. Francis Gary Powers was piloting the aircraft and was captured soon after the downing.[106] The Powers incident caused political

[104] Ehrhard, 6.

[105] Ibid.

[106] Richard Whittle, *Predator: the Secret Origins of the Drone Revolution* (New York: Picador, 2015), 21.

embarrassment and affected U.S.–Soviet treaty negotiations at the Paris Summit between President Dwight Eisenhower and Premier of the Soviet Union Nikita Khrushchev.[107]

The United States secretly awarded Ryan Aeronautical Company a contract for its Q-2 Firebee target drone for reconnaissance eight days after Powers' capture. Flight tests soon began but were quickly blocked a few weeks later due to the political prioritization of Department of Defense funds. Senior leaders wanted to acquire the new SR-71 spy plane because it was capable of Mach 3 speeds and able to fly at altitudes no Soviet surface-to-air mission could reach. Senior leaders felt that the Boeing SR-71 supersonic reconnaissance aircraft was better suited to fit the service's needs at the time.[108] In 1960, the Air Force sent the Secretary of Defense a $1 million plan for the development of unmanned aircraft, but it stalled as President John F. Kennedy's administration was entering the White House.[109]

The Air Force finally awarded Ryan Aeronautical the contract in February 1962, which correlated with the "Big Safari" program to modify four Q-2C Firebees and call them special purpose aircraft. Big Safari was a contracting and procurement organization meant to streamline the acquisition process.[110] The company was meant for highly classified and quick-reaction aircraft modifications. Big Safari's programs had little oversight or paperwork. Big Safari and Ryan Aeronautical modified the Q-2C special

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[107] Ehrhard, 6.

[108] Whittle, 21.

[109] Blom, 56.

[110] The sped up acquisition and development process used by Big Safari is called "rapid prototyping" today.

purpose aircraft by adding an improved onboard camera. This variation was called the Ryan 147 "Fire Fly." The test flight included round-trip missions from Holloman Air Force Base, New Mexico, to slightly west of the Great Salt Lake in Utah after being air launched from a C-130.[111] The Fire Fly proved that a pilotless aircraft could have a quality camera outfitted and that it could perform required reconnaissance up to expectations.

Meanwhile, on 27 October 1962, one day before the end of the Cuban Missile Crisis, another U-2 was shot down over Cuba, killing the pilot.[112] The strategic dangers and ramifications of people being captured or, as in this case, killed highlighted to the Air Force the need to embark on surveillance drone projects.[113] The use of unmanned aircraft never seemed able to build on its momentum due to political intervention or poorly prioritized asset development. The reason the political influence and faulty prioritization are important is because they led to a lack of adequate fielded capabilities in required quantities at the onset of conflict future conflicts, or wars.

The next task for the Fire Fly was survivability. How could an unmanned aircraft last in a non-permissive environment, particularly against fighter aircraft? The aircraft was reconfigured as a target and employed against four F-106 Delta Darts, each loaded with four air-to-air missiles. The four aircraft fired all of their missiles at the 147A but failed to hit the target from a rear aspect position, proving the promising future of the

[111] Ehrhard, 6.

[112] Whittle, 21.

[113] Newcome, 71-72.

small-signature, speedy, and stealth-enhanced Fire Fly.[114] The successful trials bolstered the argument that the aircraft could be extremely beneficial in various combat situations. The success of these tests validated the aircraft's worthiness and led to further contracts requiring Ryan Aeronautics to build nine more Fire Fly variants, which had a wing span 27 feet longer than earlier models, a fuselage that was four-feet longer, and an operating altitude of 62,500 feet.[115]

Unfortunately, not everyone saw positives to the program, and the commander of Tactical Air Command stated that he "wanted no part of unmanned aircraft." The Fire Fly's developers shipped the concept to numerous Air Force agencies until the Strategic Air Command Director of Operations, Major General William H. "Butch" Blanchard, recognized their value and accepted putting them under his command. In July 1963, the first drone reconnaissance unit in the Air Force became operational as members of the 4080th Strategic Reconnaissance Wing. In 1964, the Air Force tested further models such as B, C, D, and E; however, sentiments like those of the Tactical Air Command commander were pervasive, and many individuals in the Air Force resisted the use of drones for fear of replacement or a lack of confidence in the technology.[116] Continuing the legacy of the 3025th, the Strategic Reconnaissance Wing revealed how its value was on the rise, despite an aversion to what unmanned aircraft represented for the future of the Air Force.

[114] Blom, 55. The data points collected laid the framework for future development, as UASs became more capable leading into the late 1990s and early 2000s.

[115] Ibid.

[116] Ibid., 56-58.

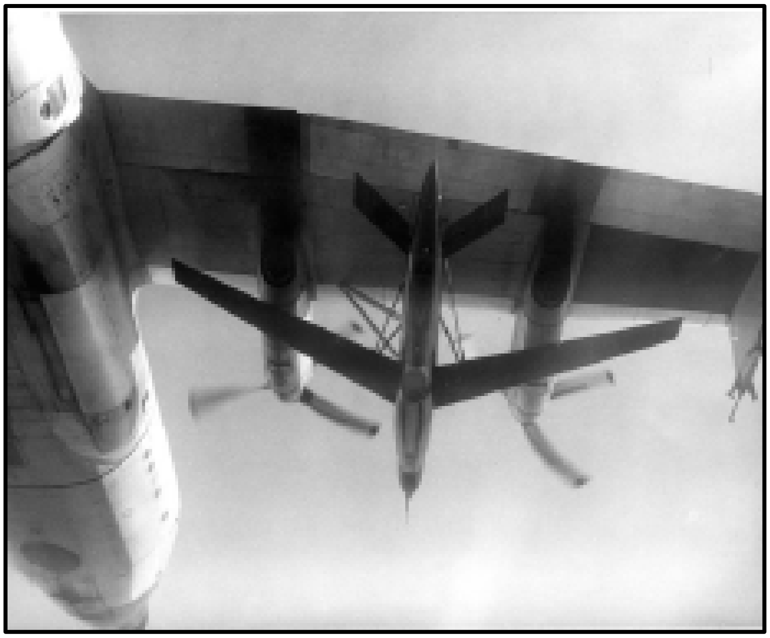

Figure 9. Fire Fly Ready to Launch from DC-130

Source: Thomas P. Erhard, *Air Force UAV’s: The Secret History* (Arlington, VA: Mitchell Institute Press, 2010), 5.

Figure 10. Fire Fly in Flight

Source: Thomas P. Ehrhard, *Air Force UAV's: The Secret History* (Arlington, VA: Mitchell Institute Press, 2010), 7.

The Cuban Missile Crisis

The U-2 discovery of a nuclear missile facility and SAM locations in Cuba on 14 October 1962 led to opportunity for the UAS community.[117] The SA-2 Guideline Missile threat was considered a high priority; this was the moment during which the Fire Fly could prove its merit. Dr. Joseph V. Charyk, undersecretary of the Air Force and national reconnaissance chief, advocated strongly for the use of the Fire Fly to do reconnaissance over Cuba. Just before conducting the mission, it was aborted at the last minute out of fear that the Soviets might find out about the secret Fire Fly project and its capabilities.[118] Despite the potential for war, the United States did not use its UAS technology, which might have revealed the value and potential of the system as an asymmetric advantage.

One ever-increasing challenge was the cost of the systems. Some improvement programs cost the government $13 million, or $86 million in fiscal year 2010 dollars, which equated to $12.3 million dollars per aircraft in today's conversion. One of the Air Force's avenues for developing of UAS technology was through joint ventures with the CIA. The capture of CIA operative pilots and the sensitive nature of such captures necessitated that the CIA heavily look into unmanned technology. Additionally, the joint Air Force–CIA venture proved beneficial for both parties, because the Air Force provided aviation experts and the CIA offered a budget that allowed for riskier development designs and practices. Finally, the Cold War and the requirement to gather intelligence over vast areas allowed for public acceptance of UASs as well.[119] The intelligence

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[117] Ehrhard, 7-8.

[118] Ibid., 8.

[119] Ibid., 5.

community appreciated the technology for what UASs afforded it: close to the same reward but less risk.

The tug of war between technological revolution and man's demand for relevance in manned aircraft became a common theme during the Cold War and throughout UAS history. The concerns over robotic replacements for humans only grow as technology develops exponentially. The Air Force's challenge, from 1960 until today, is finding the balance in sharing the burden of relevance with all stakeholders. This is a telling glimpse into the mindset of why the use of unmanned aircraft continued to be constrained despite glaring operational demonstrations of success. The advancements in technology and modifications proved valuable for subsequent conflicts, namely, Vietnam.

CHAPTER 5

VIETNAM AND POST-VIETNAM

> Drones went into areas where conventional airplanes wouldn't live. You could not take an RF-4 and fly it, by itself, up into the heavily defended areas and expect to get out alive. It would come back shot up, or it wouldn't come back with the photography. They were the main source of battle damage assessment.
>
> — General John W. Vogt, quoted in Richard H. Kohn and Joseph P. Harahan, *Air Interdiction in World War II, Korea, and Vietnam*

Until the conflict in Afghanistan, Vietnam was the longest war in US history. Similar to the power struggle between the United States and the Soviet Union during the Cold War, the political interests in Vietnam revolved around containing communism. In their expansionist efforts, the French claimed Vietnam as a colony in 1887, seeking oil and rubber from the region.[120] One major factor that led to American involvement in Vietnam was the First Indochina War (1946–1954) between France and Vietnam. After the French experienced a humiliating defeat at Dien Bien Phu in 1954, negotiations resulted in the Geneva Agreements of 21 July 1954, which divided Vietnam at the 17th parallel. North Vietnam was led by Ho Chi Minh and the communist government, while South Vietnam was led by President Ngo Dinh Diem. North Vietnamese aggression and influence seeped into South Vietnam through North Vietnamese forces as well as South Vietnamese guerillas and conventional forces known as the Viet Cong.[121] As a whole, the Vietnam War lasted from 1 November 1955 through 30 April 1975; however, the signing

[120] Richard Stewart, *The U.S. Army Campaigns of the Vietnam War: Deeping Involvement 1945–1965* (Washington, DC: Center of Military History, 2012), 5-7.

[121] HistoryNet, "Vietnam War: Facts, Information and Articles about the Vietnam War," accessed 6 January 2016, http://www.historynet.com/vietnam-war.

of an economic and military aid treaty between the United States and South Vietnam resulted in overt US involvement starting in 1961.

The American strategy going into Vietnam was based on an amalgamation of political, economic, and military measures to defeat the insurgency by eliminating the unrest and discontent. Indecisiveness existed in how the military, particularly its ground forces, should prosecute the war. This uncertainty left General William Westmoreland, commander of Military Assistance Command, Vietnam, with little choice but to rely on airpower and covert operations to interdict Viet Cong external operational and logistical lifelines.[122] The unconventional counterinsurgency environment presented by Vietnam and Southeast Asia resulted in the military employing a variety of resources. What began as foreign aid missions grew to include aircraft, support equipment, and manpower.

Aerial reconnaissance was at a premium for intelligence professionals working in the theater. Photographs captured numerous high-value systems such as the Soviet heat-seeking air-to-air missiles loaded on *Mikoyan-i-Gurevich*-21 (MiG-21) aircraft that were airborne over North Vietnam and pictures revealing optical tracking capabilities that fed acquisition data to SAM systems.[123] The reconnaissance photos were especially valuable for commanders to gain a situational understanding of the battlefield, defensive orders of battle, and possible enemy vulnerabilities. Drones were one of the most valuable assets in collecting reconnaissance photos during the Vietnam War. To maintain secrecy, drone

[122] Andrew J. Birtle, *U.S. Army Counterinsurgency and Contingency Operations Doctrine, 1942–1976* (Washington, DC: Center of Military History, U.S. Army, 2006), 362-363.

[123] Elder, xi.

reconnaissance programs held multiple code names, such as BLUE SPRING, Bumble Bug, Bumpy Action, and finally, in February 1970, Buffalo Hunter.

The Lightning Bugs Swarm

In the early 1960s, the United States continued to maintain basic Model 147 Firebees in its inventory. The Air Force realized it needed improved versions of the Firebee to compensate for possible demands and varieties of mission sets. This led to the development of the Ryan 147 "Lightning Bug," which was a variation of the Firebee used during the Cold War. Lightning Bugs entered the Pacific theater before the U.S. intervention in the Vietnam conflict. Lightning Bugs became the aircraft of choice after the People's Liberation Army Air Force shot down multiple CIA U-2 aircraft.[124] The first Lightning Bug missions flew over China on 20 August 1964.[125] However, as the U.S. military's focus began to pivot from China to Vietnam, so too did the direction of Lightning Bug assets, which began seeing action over North Vietnam in late 1965. The Lightning Bugs gave developers the ability to create niche variations quickly to overcome specific threats or challenges. For example, the weather and cloud coverage in the area spurred the creation of a low-altitude variant. Low-altitude operations increased the survivability of the drone, as chances to engage them were limited. The rapid

[124] Zaloga, *Unmanned Aerial Vehicles*, 12. The Lightning Bug was extremely beneficial for aerial reconnaissance but operated poorly during the monsoon months of November through March as most targets were obscured by clouds.

[125] Newcome, 83.

development process and tempo of UASs was beneficial and not easily replicated in manned aircraft.[126]

President Lyndon Johnson had concerns of possible Chinese involvement in the war, mirroring their participation in Korea. The president authorized Lightning Bug reconnaissance usage over Southern China and allowed basing at Kadena Air Force Base in Okinawa. These missions were named BLUE SPRINGS. Their base of operations was transferred to Bien Hoa Air Base in South Vietnam in October 1964. As Lightning Bugs flew into China, the Chinese shot down numerous drones. This benefited them twofold: first, the downed aircraft provided the Chinese with enough material and examples to potentially reverse engineer the technology. Second, the downed aircraft were put on public display in an effort to embarrass the American government. However, much to China's dismay, due to a lack of human casualties or captured pilots being paraded in front of cameras, the press in the United States ignored the story and propaganda.[127]

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[126] Zaloga, *Unmanned Aerial Vehicles*, 12.

[127] Sloggett, 80–81.

Figure 11. Lightning Bug over Vietnam

Source: Ian G. Shaw, "The Rise of the Predator Empire: Tracing the History of U.S. Drones," Understanding Empire, 2014, accessed 25 August 2015, https://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/.

Lightning Bug Variants

The different variants of Lightning Bugs were not just capability demonstrators, but also a testament to focused American ingenuity. Vietnam proved to be a pivotal time for UAS growth. The platforms were robust and easily modified into variants with various missions. The Air Force saw 23 versions of the Lightning Bug created, most with unique specialties. Their downside, similar to UASs in the current-day inventory, is that

they were not line-replaceable modifications, so each one was held for certain types of missions, which limited flexibility.[128]

As mentioned, a low-altitude variation of the Lightning Bug was created that was capable of flying at 1,000 feet AGL and above at speeds of 500–540 knots. This provided the military with reconnaissance capability below the weather as well as below some of the thresholds of the certain ground-launched missile parameters. One variant was fitted with chaff dispensers and active jamming systems. This type proved beneficial in forcing the enemy to expend missiles, while keeping manned aircraft safe. Another variant was created for carrying propaganda leaflets, which allowed for psychological campaigns to augment the air and ground efforts.[129] Other versions included night capability with strobe flashes to illuminate the target area, as well as signals intelligence (SIGINT) and electronic antiradar jamming versions.[130] Some aircraft saw the outfit of air-to-ground missile launchers, which included AGM-65 Maverick and Stubby Hobo TV-guided missiles and 250- and 500-pound general-purpose bombs.[131] The creation of multiple variations showed the flexibility of UASs and created a demand for them in Southeast Asia. Lightning Bugs proved capable of executing missions that manned aircraft could

[128] Line replaceable modifications refer to new hardware or software that provides a specific capability. This capability can be added to the aircraft when a specific mission requires it and removed for other flights, which provides an aircraft fleet the greatest flexibility.

[129] Sloggett, 80-87. The low-altitude version of the Lightning Bug normally flew at 500–540 knots but could go upwards of 590 knots if needed.

[130] Zaloga, *Unmanned Aerial Vehicles*, 14.

[131] Newcome, 83.

not due to risk and survivability. However, one major issue with the Lightning Bug was retrieving the collected reconnaissance photos.

Table 1. Model 147s in Vietnam

Ryan Model	Military Model	Length	Wing Span	Thrust (lbs.)	Mission	Operational Period	Number Launched	% Return
A		27'	13'	1700	Fire Fly - first demo drone	Apr 62-Aug 62		
B		27'	27'	1700	Lightning Bug - first big-wing high-altitude day photo bird	Aug 64-Dec 65	78	61.5%
C		27'	15'	1700	Training, low altitude tests	Oct 65		
D		27'	15'	1700	From C, electronic intel	Aug 65	2	
E		27'	27'	1700	From B, high-altitude electronic intel	Oct 65-Feb 66	4	
F		27'	27'	1700	From B, high-altitude electronic intel	Jul 66		
G		29'	27'	1920	Longer B with larger engine	Oct 65-Aug 67	83	54.2%
H	AQM-34N	30'	32'	1920	High-altitude photo; more range	Mar 67-Jul 71	138	63.8%
J		29'	27'	1920	First low-altitude day photo	Mar 66-Nov 67	94	64.9%
N		23'	13'	1700	Expendable decoy	Mar 66-Jun 66	9	0.0%
NX		23'	13'		Decoy and medium-altitude day photo	Nov 66-Jun 67	13	46.2%
NP		28'	15'	1700	Interim low-altitude day photo	Jun 67-Sep 67	19	63.2%
NRE		28'	13'	1700	From NP, first night photo	May 67-Sep 67	7	42.9%
NQ		23'	13'	1700	Low-altitude NX, hand-controlled	May 68-Dec 68	66	86.4%
NA/NC	AQM-34G	26'	15'	1700	Chaff and electronic-countermeasures	Aug 68-Sep 71		
NC	AQM-34H	26'	15'	1700	Leaflet dropping	Jul 72-Dec 72	29	89.7%
NC(M1)	AQM-34J	26'	15'	1700	Interim low-altitude day photo and training			
S/SA		29'	13'	1920	Low-altitude day photo	Dec 67-May 68	90	63.3%
SB		29'	13'	1920	Improved SA low-altitude	Mar 68-Jan 69	159	76.1%
SRE	AQM-34K	29'	13'	1920	From SB, night photo	Nov 68-Oct 69	44	72.7%
SC	AQM-34L	29'	13'	1920	Low-altitude workhourse	Jan 69-Jun 73	1651	87.2%
SC/TV	AQM-34L/TV	29'	13'	1920	From SC, with real-time TV	Jun 72-	121	93.4%
SD	AQM-34M	29'	13'	1920	Low-altitude photo, real-time data	Jun 74-Apr 75	183	97.3%
SDL	AQM-34M(L)	29'	13'	1920	From SD, with Loran navigation	Aug 72	121	90.9%
SK		29'	15'		Navy operation from aircraft carrier	Nov 69-Jun 70		
T	AQM-34P	30'	32'	2800	Larger engine; high-altitude day photo	Apr 69-Sep 70	28	78.6%
TE	AQM-34Q	30'	32'	2800	High-altitude; real time communications intel	Feb 70-Jun 73	268	91.4%
TF	AQM-34R	30'	32'	2800	Improved long-lange TE	Feb 73-Jun 75	216	96.8%

Source: John D. Blom, *Unmanned Aerial Systems: A Historical Perspective* (Fort Leavenworth, KS: Combat Studies Institute, 2010), 57.

Mid-Air Retrieval System (MARS)

The Vietnam War saw UASs perform reconnaissance in large quantities, but each mission was relatively complex, based on their launch, execution, and recovery. Before 1966, the Lightning Bugs were air-launched from man-piloted DC-130 aircraft. These cargo aircraft were specifically configured to carry, launch, monitor, and if necessary, control the drones on the reconnaissance missions. In essence, it was an aircraft launching an aircraft. A DC-130 was capable of carrying four drones: however, the standard was two drones, one primary and one backup. The DC-130s were usually launched in pairs so that there was launch redundancy. In addition to the standard C-130 flight crew—pilot, copilot, navigator, and flight engineer—the DC-130s had two launch control officers, an airborne recovery control officer, and a radar technician who monitored the Microwave Command Guidance System, which provided line-of-sight acquisition, identification, tracking, and control of the drones from launch until recovery.[132]

Normally, the drone crew inputted waypoints into the Lightning Bug so that it flew a preprogrammed mission.[133] Along the mission, the navigation system kept the aircraft on its path and the camera system took photos of desired targets or areas of interest. A drone's flight time was typically 55 minutes in length and covered 430 nautical miles. In total, the drones cost approximately $200,000 each, including

[132] Elder, 6.

[133] Newcome, 84. For missions over China, the DC-130s took off from Kadena Air Force Base at dawn, launched the drone off to China at noon on its two-to-three hour preprogrammed mission (no en route corrections were made), and then returned to Kadena. Meanwhile, the drone returned over Taiwan, where it deployed a parachute over a predesignated location, and a second C-130 flew it back to Kadena that evening.

navigation systems and cameras.[134] When the drone completed its reconnaissance mission, it flew to a predetermined point for recovery, deployed a parachute, and floated to the ground. A second DC-130 retrieved the drone from the recovery site, removed and packaged the film, put it onboard a courier jet, and flew the film to Offutt Air Force Base, Nebraska, for interpretation, due to limited in-theater processing.[135] Chute landings proved ineffective because early versions landed over South Vietnam—sometimes in a rice paddy, in the jungle, in the ocean off of Da Nang, or in hostile territory. Additionally, landings usually resulted in damage to the drone and the film on the aircraft. The military sought a new method of recovery to preserve the intelligence.

In 1966, developers created another component that increased the effectiveness of drone reconnaissance by increasing the survivability of the coveted collected photos. This led to the Mid-Air Retrieval System (MARS), which was one of the most creative aspects of the Lightning Bug. The H-model became the first MARS-capable Lightning Bug, which eliminated damage to the drone and the onboard film during landings. The MARS consisted of the drone and a CH-3H Little Jolly helicopter, later to be replaced by a CH-53 helicopter.[136] To avoid damage from hard landings, saltwater contamination, or just losing the drone, the Lightning Bugs were plucked from midair by a CH-3C helicopter after the parachute opened. The aircrew manipulated two 20-foot-long hydraulically operated poles and an array of three hooks. The helicopter crew snagged the parachute's

[134] Elder, 4-6. The $200,000 price per drone in 1966 equates to approximately $1,460,000 in 2016.

[135] Newcome, 84.

[136] Zaloga, *Unmanned Aerial Vehicles*, 14.

cords and, with a winch that fed 1,000 feet of steel cable out of a reinforced hole in the helicopter's floor, reeled the 2,000-pound drone into a position about 20 feet underneath the helicopter. Once collected, the helicopter delivered the drone to a recovery zone.[137] Despite its complexity, MARS proved to be an achievement in innovative recovery methodology. Out of 2,745 attempted recoveries, 2,655 were successful, for a nearly 97 percent success rate.[138] After the drone was brought back to base, the onboard still-photo film cartridge then had to be flown out of Vietnam for development and analysis, with photos of interest flown back later.[139] Unfortunately, the process sometimes took days to go round-trip.

[137] Rogers and Hill, 22.

[138] Sloggett, 81.

[139] Rogers and Hill, 22. Future generations of UASs tried to overcome the delayed timeline in recovering. As technology developed, the capability to transmit full-motion video decreased the time–space gap, increasing the speed of commander decision cycles.

Figure 12. CH-3C Helicopters used by the 100th Strategic Reconnaissance Wing to Recover Drones Mid-air

Source: MSgt Vincent L. Daubenspeck, Report, History of the 432d Tactical Drone Group: Davis Monthan Air Force Base Arizona, 1 October-31 December 1976, Box K-GP-RCN-432-HI (October-December 1976)–K-GP-RCN-432-HI (January-June 1977), File K-GP-RCN-432-HI (1 October 1976-31 December 1976), Air Force Historical Research Agency, Maxwell Air Force Base, AL.

Figure 13. Drone Hanging from its Parachute as it Floats Downward

Source: MSgt Vincent L. Daubenspeck, Report, History of the 432d Tactical Drone Group: Davis Monthan Air Force Base Arizona, 1 October-31 December 1976, Box K-GP-RCN-432-HI (October-December 1976)–K-GP-RCN-432-HI (January-June 1977), File K-GP-RCN-432-HI (1 October 1976-31 December 1976), Air Force Historical Research Agency, Maxwell Air Force Base, AL.

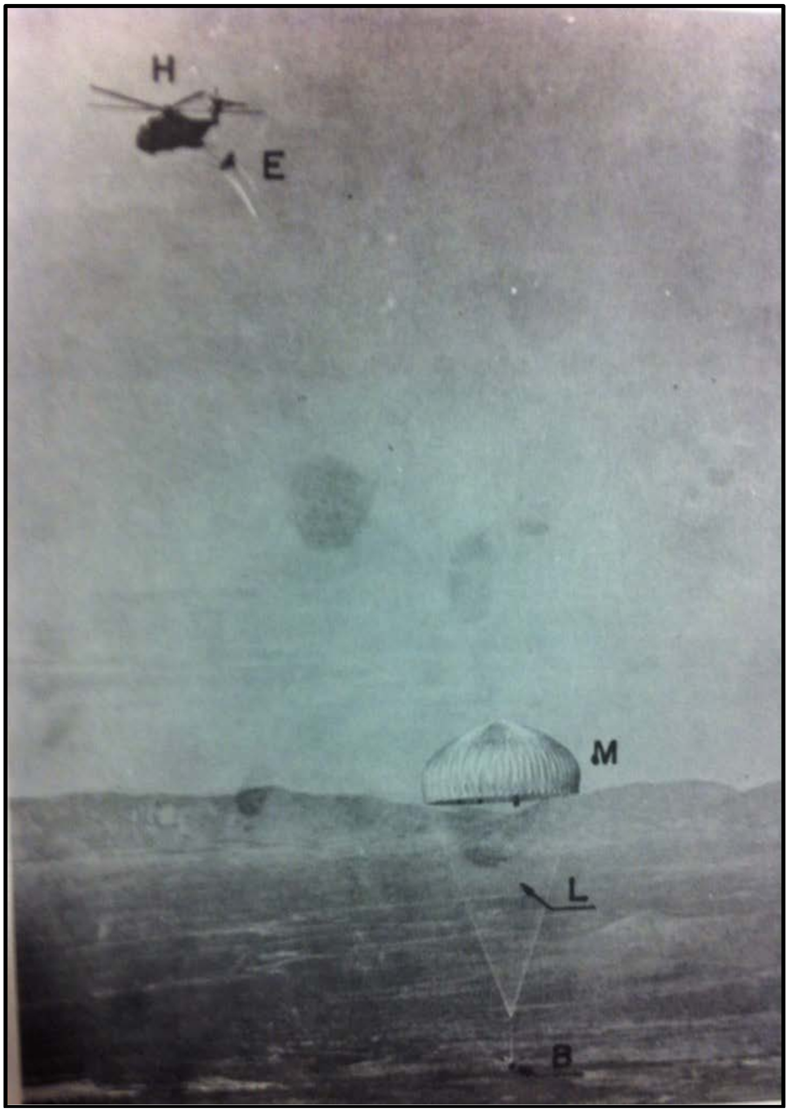

Figure 14. The Helicopter's Retrieval Hooks have Caught the Parachute Executing the MARS Process

Source: MSgt Vincent L. Daubenspeck, Report, History of the 432d Tactical Drone Group: Davis Monthan Air Force Base Arizona, 1 October-31 December 1976, Box K-GP-RCN-432-HI (October-December 1976)–K-GP-RCN-432-HI (January-June 1977), File K-GP-RCN-432-HI (1 October 1976-31 December 1976), Air Force Historical Research Agency, Maxwell Air Force Base, AL.

Operational Effectiveness

The inventiveness of MARS and the assortment of drones provided during Vietnam required extensive manpower and financial resources to enable these operations. Launching a Lightning Bug required a cargo aircraft, the drone, and a helicopter for retrieval. This resource draw demanded that the benefits of the program be extensive enough to validate the continued use of the systems. Vietnam proved to be the coming-out party for UAS in the U.S. Air Force and a turning point in how drones were employed. The operational tempo of the drone program was far-reaching, and it proved to be a major influence in the conflict. In the decade from 1964 to 1974, 1,016 Lightning Bugs flew 3,435 sorties over China, North Vietnam, and North Korea—equating to nearly a sortie per day. Specifically in Vietnam, drones accounted for nearly half of the total missions. The Fairchild 415Y low-altitude camera on the Lightning Bug was advanced enough to provide usable 120-nautical-mile strips of imagery in three-nautical-mile swaths that resolved objects as small as six inches.[140] The Lightning Bugs recovered over 100,000 feet of film for intelligence exploitation.[141] These successes in high-volume reconnaissance were acknowledged by senior leaders. On 17 June 1983, retired General

[140] Rogers and Hill, 22. According to Paul W. Elder, the camera loaded on the low-altitude variant was a Fairchild 415Y (still picture, rotary prism, moving film, and panoramic type) designed specifically for the low drone. It provided 180 degrees of lateral coverage transverse to the flight path (i.e., horizon-to-horizon) when the drone flew straight and level. Carrying 1,800 feet of 70-millimeter film at 1,500 feet of altitude, the camera was capable of 120 nautical miles of continuous longitudinal (along-track) photographic coverage with 60 percent frame overlap. The usable lateral coverage (swath width) was three nautical miles from 1,500 feet and one to two nautical miles from 500 feet. The nadir resolution of the camera, which had a three-inch focal length, was an optimum six inches at 1,500 feet and one foot at 1,000 feet. Elder, 3.

[141] Newcome, 86.

John Vogt, who previously held the positions of Seventh Air Force Commander and Deputy Commander Military Assistance Command, Vietnam stated, “I am a great believer in drones. I used drones in a reconnaissance role very effectively.”[142]

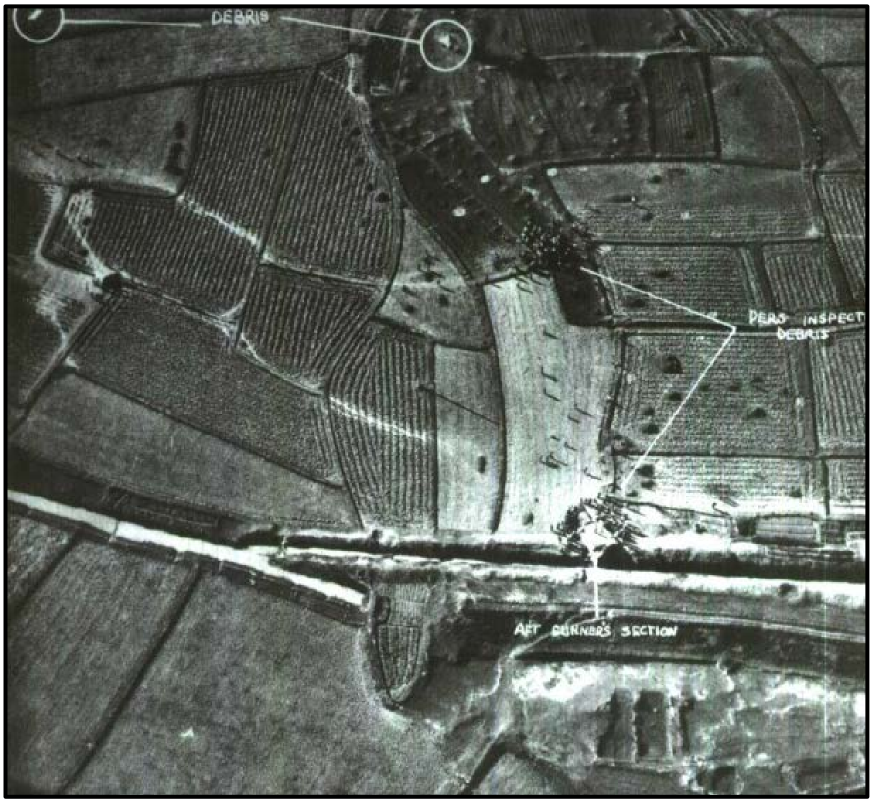

Figure 15. Photograph Showing the Drone’s Low-altitude Photographic Capability of a B-52 Crash Site with People Surrounding the Debris

Source: Paul W. Elder, *Project CHECO Southeast Asia Report: Buffalo Hunter 1970–1972* (Hickam AFB, HI: Headquarters Pacific Air Forces, CHECO Division, 1973), 5, accessed 3 October 2015, http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA486697.

[142] Kohn and Harahan, 88.

Another operational success in Vietnam was that the first UASs were employed as SIGINT and suppression of enemy air defense platforms. Unmanned aircraft were ideal for these roles in Southeast Asia because the preponderance of missions required exposure to enemy threats with the possibility of engagement. Due to the range and number of key radar systems in Vietnam, U.S. commanders needed aircraft to get within the radar's line-of-sight to gather data on those radars' operating parameters. Manned aircraft encountered difficulty in overcoming radar systems deployed in a point defense because of the intelligence collection challenge they created. As the American people began to question the validity of U.S. involvement, minimizing casualties was an important component for maintaining national will in the conflict. UAS removed the risk to pilots in the areas where radar systems tracked and engaged aircraft.[143]

One mission uniquely suited to drones was SIGINT acquisition of SAM sites. The relatively new danger SA-2s presented required that all aircraft operate at standoff distances that were inadequate to execute appropriate reconnaissance, according to for Air Force and Army leaders. The Lightning Bug was the right tool for the problem. The Lightning Bug E-model was equipped with an active radar-enhancing device to ensure that the SA-2 Fan Song fire control and tracking radar detected the aircraft. On 13 February 1966, the Lightning Bug made history when it detected the command-link signal from the Fan Song E radar system and transmitted the data before the aircraft was destroyed. This was a pivotal moment in the Vietnam War because it provided military leaders with the two uplink channels used to control the SA-2 missile. The uplink channels gave the military the ability to either jam or manipulate the command signals so

[143] Sloggett, 81-82.

that the missiles missed their targets. More importantly, the information enabled the development of safety measures for manned aircraft. The uplink channels spurred development of radar warning receiver technology on manned aircraft so pilots would know when the SA-2 command link became active and an engagement was imminent, giving them time for appropriate defensive maneuvers.[144]

In 1965, North Vietnam introduced high-altitude SA-2s, forcing manned American U-2 reconnaissance aircraft to fly standoff missions, during which they took reconnaissance photos outside of the missile's engagement zone. Once again proving its worth, the Lightning Bug took over most of the high-risk penetration flights into North Vietnamese airspace to reduce unnecessary risk.[145] The drones were also credited with the losses of numerous enemy MiG fighter aircraft, which either crashed by trying to intercept the drones or were hit by SAMs that missed the drones during missile engagements. Interestingly, one drone earned "ace" status because it was involved in the loss of five North Vietnamese fighters. The unmanned aircraft also proved to be far more resilient than anyone expected. The anticipated life expectancy of a Lightning Bug in combat over Vietnam was only 2.5 sorties, but they ultimately averaged 7.3 missions. The record was set by an S-model called "Tom Cat," which flew 68 sorties before being lost on 25 September 1974.[146]

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[144] Sloggett, 82-83.

[145] Newsome, 83.

[146] Zaloga, *Unmanned Aerial Vehicles*, 14-15. "Ace" status within the Air Force has always been culturally important. To achieve it, traditionally, a person has to shoot down five enemy aircraft. During Vietnam, only five U.S. aviators earned ace status from their work strictly in Vietnam. Two were pilots, and three were weapon systems officers (Air Force) or radar intercept officers (Navy). Robin Olds earned his third ace in

The Lightning Bug program was not without its issues. During the war, 544 drones were lost, a third of which were due to mechanical issues that led to crashes or unsalvageable failures. SA-2 Guideline missiles, fighter aircraft, or anti-aircraft artillery shot down the remaining two thirds.[147] Early on, the Air Force struggled with ensuring that missions went according to plan. Some drones made mysterious turns while in flight and never returned; one failed to switch to remote control for landing and flew past the recovery zone before running out of fuel. Even when everything did go right, the Lightning Bugs often sustained considerable damage upon landing.[148]

As the Vietnam War ended, the successes of the UAS program were evident. One of the main contributing factors was the fleet of leftover Firebee drones and equipment that were still serviceable as Vietnam began. This translated (with little major innovation) into the Lightning Bug program cutting down on development time and speeding up operator training, organizational growth, and tactical employment.

Post-Vietnam: 432d Tactical Drone Group

The rapid development and deployment of UAS technology left the Air Force behind the power curve when meeting training requirements. The reconnaissance drones entered production just prior to the escalation of the war; therefore, the Air Force had limited time to train personnel before placing them in theater. The second problem had to

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Vietnam, but only four of his overall 16 kills were in Vietnam; the rest were in World War II.

[147] Zaloga, *Unmanned Aerial Vehicles*, 14. Lightning Bug use fluctuated during its employment in Vietnam. Notable increases in UASs flights occurred during the Tet Offensive on 30 January 1968 and during Operation Linebacker in 1972.

[148] Blom, 58.

do with the outlook of Air Force personnel regarding career progression within the UAS community. Many reconnaissance aviators believed, perhaps correctly, that working in a drone unit instead of a U-2 unit would stall their careers. In an attempt to rectify this, the Air Force eventually created an airborne missile-maintenance squadron, which put Lightning Bug units on the same organizational level as the U-2 units.[149] Unmanned aircraft also saw a shift in naming from UAS to RPV to highlight the pilot aspect of the system.[150] However, programs are only as good as the leaders who push them, and when senior-level acceptance for RPVs was still noncommittal, this indifference reverberated throughout the lower echelons.[151]

Activated on 1 July 1976, the mission of the 432d Tactical Drone Group (432 TDG) was to maintain capability to deploy the reconnaissance drone force (as directed by the Commander-in-Chief of Readiness Command) to any theater; this involved conducting reconnaissance drone operations and any conduct necessary training or testing to reach initial operational capability. A byproduct of the unit was the creation of an environment of inclusion and self-worth among pilots who felt negatively affected by the drone assignment. The unit was located as a tenant unit of 355th Fighter Training Wing

[149] Blom, 62. This was an important conundrum for the Air Force to address because the pilots' beliefs resulted in decreased morale in drone units. Pilots who were sent to those units felt as though their careers were over or assumed that they were at the bottom of the pack when compared to their peers.

[150] Newcome, 85.

[151] One significant event in October 1965 helped the perceptions of UAS. In a joint U-2/RB-47/Lighting Bug mission, the drone purposely drew SA-2 fire while the U-2 and RB-47 stood aside to record and report on the intercept tactic used. That cooperation for a common cause—plus the visual impact of watching what a SAM could do to an aircraft—helped convert reconnaissance pilots.

(355 FTW) but was subordinate to the 12th Air Force.[152] The group consisted of the 432d Drone Maintenance Squadron (432 DMS), 432d Organizational Maintenance Squadron (432 OMS), 11th Tactical Drone Squadron (11 TDS), 22d Tactical Drone Squadron (22 TDS), and 432d Headquarters Squadron (432 HSS).

The 432 TDG leadership encompassed a melting pot of aeronautical specialties. At the end of 1976, the aircraft flown by the group included nine DC-130A/E Hercules and RC-130A aircraft, nine CH-3E Jolly Green helicopters (MARS modified), and 45 AQM-34 Lightning Bugs of various versions (L, M, and V). Even after the Vietnam War ended, the unit continued to develop the systems.[153]

While the group found successes in Vietnam because of the intense involvement of its aircraft, one of the major issues it faced was manpower. In contrast to the previous 3205th Drone Group, the 432 TDG had relatively good manpower numbers on paper. For example, in December 1976, the group was authorized 708 officers, airmen, and civilians, and it was assigned 777 (110 percent). The more glaring issue related to ensuring that personnel were qualified and combat-ready. The training was specialized and traditional pilots required considerable training time to effectively operate the UASs. The unique nature of the drone group meant there was not a pool of Air Force members who could transition easily into the jobs. The UAS offered a capability that the enemy had difficulty countering, but it also created a stovepipe in training and manning. Due to

[152] MSgt Vincent L. Daubenspeck, Report. History of the 432d Tactical Drone Group: Davis Monthan Air Force Base Arizona, 1 October–31 December 1976, Box K-GP-RCN-432-HI (October–December 1976) – K-GP-RCN-432-HI (January–June 1977), File K-GP-RCN-432-HI (1 October 1976–31 December 1976): 1-1, Air Force Historical Research Agency, Maxwell Air Force Base, AL.

[153] Ibid., 4-2.

long assignments with the program, the 432 TDG lost large portions of its experienced personnel in an effort to balance careers and mission. While this is normal in most career fields, the UAS community failed to establish career paths for its pilots, enlisted operators, and mechanics.[154] By losing experienced personnel, and receiving inexperienced people, the overall skill level decreased. The group had to train the new arrivals and still maintain a high sortie rate. This left the group in the precarious position of not having an experienced aircrew to train those without proficiency.[155]

The ad hoc methodology of developing the UAS organization without first creating a foundational career model affected the overall efficiency and morale of the airmen. These challenges were also seen in the early MQ-1 Predator years, when people were brought from manned aircraft units and had no established career paths. This was exacerbated by community's substandard views of unmanned aircraft relative to manned aircraft. Without strong leadership and planned measures to ensure that operators had the same opportunities as others in the Air Force, the UAS program found itself fighting external wars amidst internal conflict. As the Air Force struggled to find a place for drones within its culture, the civilian sector was embracing the technology with open arms.

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[154] The lack of a career path decreased morale in the units because it accentuated the destructive effect that UAS assignments had on traditional pilots. This issue also surfaced in the RPA community of the 21st century. The lack of career path and development led to many people leaving the military because their careers were stifled.

[155] Daubenspeck, 2-1.

The Fight for Legitimacy

The divisiveness of the Vietnam War created a societal acceptance of unmanned aircraft that stimulated the civilian population's imagination. In 16 November 1970, *Aviation Week & Space Technology* devoted an entire issue to the topic. The numerous articles expressed people's intrigue regarding the notion of unmanned flight and forecast definite possibilities on multiple fronts of development. In the military, the use of unmanned aircraft prompted new ideas and reexamination of previously overlooked and discarded concepts.[156] Military and civilian developers always worked closely on UAS projects. The lack of development and investment post-Vietnam allowed many civilian companies to catch up.

On 5 June 1971, Air Force General John D. Ryan stated, "drones have demonstrated an excellent potential for use in tactical reconnaissance and electronic warfare. Although the austere budget situation has had an adverse effect on the tactical drone program, actions pointed toward your needs are underway and will continue to be given full support."[157] This perspective, coming from the Air Force chief of staff, illustrated the back-and-forth nature of drone support in the Air Force hierarchy. The capability was desired because it enhanced operations, but it was always met with budget constraints that limited its full realization.

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[156] Barry Miller, "Unmanned Aircraft Gain Favor, *Aviation Week and Space Technology* 7, no. 4 (November 1970): 67.

[157] Gen John D. Ryan, Memorandum, Tactical Drones, 5 June 1971, Box 168.7041-41 (May 1971)–168.7041–54 (July 1972), Air Force Historical Research Agency, Maxwell Air Force Base, AL.

By 1973, an article in *Aviation Week and Space Technology* stated, "Ironically, it was the military that first sparked major industry interest in the UAS concept . . . but currently, the military is providing inertia preventing major progress in this field at the pace that technology now permits." The article explained how the United States had the advantage in the UAS field and that, if exploited wisely, the country could see great leaps in potential and remain one step ahead of opposition.[158] This is important—civilians saw the asymmetric benefits UASs provided and realized the fragility of the country's advantage within the technological domain.

During the mid-1970s, new ideas flourished in UAS command and control. These included concepts such as ground-control stations that were equipped so one pilot could fly multiple RPVs, autonomous aircraft that only required human intervention from target acquisition to weapon delivery, and new recovery techniques.[159] These revolutionary concepts were only realized decades later due to the lack of investment post-Vietnam. Did civilians see more potential in unmanned aircraft than the Air Force did? While the Air Force realized the potential of UASs, the Department of Defense constrained budgets limited development and active research. Additionally, the lack of a war meant that there was no longer a necessity for the systems to fill capability gaps. The end of the military involvement in Vietnam was not the end of the Lightning Bug. While the war had created

[158] Robert Hotz, "The Promise of RPVs," *Aviation Week and Space Technology* (January 1973): 7.

[159] The ground-control station is a box where the pilot or operator sits when flying the aircraft. In modern-day RPA employment, the ground-control station is called a "cockpit" to indicate that it is where the pilots sit to fly the aircraft.

dynamic RPV technologies, the United States engulfed itself in post-war introspection and the focus shifted back toward the Cold War and operations in Europe.[160]

A commander in Vietnam and Europe, General Vogt stated in an interview, "I decided that the drone would be extremely useful in Europe, so the first thing I did when I arrived over there was say, 'I want the drones I had earmarked for my use in Vietnam. Let's bring them over, and we'll base them in England'."[161] General Vogt also discussed how he had expected the Air Force to be extremely involved in the drone business by devoting resources to research. However, he realized that the underlying stagnation created competing interests revolving around the development of the F-15 and required combat against the institutional reluctance to change. The perception that the program was driving pilots out of the cockpit was not palatable for most Air Force senior leaders, leading to an under-exploitation of UAS capability.

The battle for relevance and culture still loomed behind the scenes as Vietnam drew down and another interwar period began. The Air Force's internal conflict of capability demand and its aircrew culture were at odds, but without a war and a voice of advocacy, the unmanned aircraft community made little progress in developing either a career path for rated officers or a sense of identity. The Air Force's need to have a person in the loop resulted in repression of one of its greatest capabilities. UASs were not perfect; however, during these times of lull, the Air Force could have pressed for greater development and technological refinement. The numerous UAS successes in Vietnam were soon forgotten or willfully ignored. The suppression of enemy air defenses role was

[160] Sloggett, 87.

[161] Kohn and Harahan, 88.

taken from the UASs and given to manned aircraft due to the role's perceived glamour. The battle for relevance was not just between branches of the military but within the Air Force itself. Unmanned aircraft provided a way to determine the technological capabilities of enemy weapons and to test counter-measures, all without risking the life of the pilot.[162] The Air Force was willing to accept risk in manned platforms doing suppression of enemy air defenses without assistance from UASs. Unmanned aircraft were once again at an impasse, and development stalled until the Gulf War of 1990.

[162] Blom, 61.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

> Take, for example, unmanned aerial vehicles. In recent years there has been dramatic progress in the number, type, and capabilities of these systems. Commanders in the field have clamored for more UAVs of all types because they are ideal for many of the tasks in today's wars. They give troops the tremendous advantage of seeing full-motion, real-time, streaming video over a target–such as insurgents planting IEDs or assembling before an operation.
>
> These systems have been real game changers, and their potential is just being tapped. I should note that the Israelis were early and eager adopters of UAVs well before the U.S. military. As DCI, I tried to interest the Air Force in these platforms back in the early 1990s, but they would have none of it. An aircraft without a pilot in it held little appeal. As secretary of defense, I have a bit more say in what the military buys–and today we're pushing out as many UAVs as industry can produce. The Air Force is now training more pilots to fly unmanned systems than to fly fighters and bombers.
>
> — Secretary of Defense Robert M. Gates,
> Speech to Intelligence and National Security Alliance

The research for this thesis highlighted pioneering efforts by early Army Air Corps, Army Air Forces, and later Air Force development of unmanned aircraft. Beginning with the use of balloons, kites, and the Aerodrome No. 5, exploiting the air domain became a way to gain military advantage. The development progressed to the initial concept of a long-range, weaponized platform in the Kettering Bug, which was never used but spurred the imagination of aeronautical engineers and military alike. The pressures of the German V-1 threat inspired American inventions such as the OQ-2 Radioplane as a target platform, and Operation Aphrodite, an AAF attempt to reduce risk. Two important themes during the Cold War were the rise of organizations dedicated to drone development and the aversion of senior leaders toward unmanned technology.

Finally, the Lightning Bug had various impacts on operations in Vietnam using reconnaissance, suppression of enemy air defenses, and other roles.

Evaluating the Research Questions

The purpose of the research questions provided the foundation and framework for analysis. The primary research question pertained to how the U.S. Air Force and predecessors used unmanned aircraft in major conflicts from World War II (1939-1945) to Vietnam (1961-1973). This study showed the ebb and flow of demand for unmanned aircraft in times of war and peace. Two key points of emphasis are, first, that the capabilities each UAS version generated contributed to the systems' evolutionary, not revolutionary, process—from concept to target to reconnaissance to, ultimately, strike platforms. The research also illustrated the influence technological advancements have on tactical, operational, and strategic aims. Secondly, UASs transformed from capability demonstrators to force multipliers. The common threads over the decades of UAS development show three main uses of UASs: to advance the technological narrative, to mitigate risk, and to fill capability gaps.

UASs have been important to advancing the technological narrative within airpower. Unmanned airpower has hinged on continuous technological developments to improve anti-air defense systems, gather intelligence, or enable the gaining and maintaining of air superiority. Unmanned systems were required to promote innovative aeronautical thinking and to push new ideas into the realm of the possible. Manned aircraft developments advanced the aerodynamic platforms used for UAS, while UAS pushed developers to find new ways for manned aircraft to provide the same capabilities as unmanned aircraft and enhance certain electromagnetic spectrum upgrades. For

example, in Vietnam, the Lightning Bug launched from a DC-130 and recovered via helicopters and the MARS showed advancements for all of the aircraft communities to stretch the limits of their typical operational skillsets and inventiveness. One benefit to advancing the technological narrative was the reduction in risk to aircrew.

Second, UASs were tools to mitigate risk. The ability to keep the pilot out of harm's way and the relative expendability of UASs provided peace of mind and strategic impact. During the Cold War, downed pilots became a liability and unmanned aircraft offered a new way to exploit the reconnaissance without a loss of personnel. UASs could also collect information on SAMs, leading to the creation of radar warning receivers that helped manned pilots be aware of and avoid threats in hostile territory. Ultimately, senior decision makers did not want to continue to accept the losses of people when an unmanned aircraft could do the same job. In the 21st century, this risk mitigation has advanced to the point where people no longer need to be in the theater of operations. Current RPA developed by taking advantage of the system's greatest strength, the capability to extend the distance between person and aircraft. The systems require a smaller footprint of personnel to forward deploy, keeping the majority of aircrew in the US. What began as hundreds of feet has transformed to thousands of miles of connectivity and near-instantaneous feedback, placing fewer aircrew in danger overseas.

Third, UASs filled capability gaps. From the initial concept, unmanned aircraft were a tool to fill a need the air forces of the time were unable to satisfy. The Kettering Bug, for example, could provide the ability to strike from a long distance. The OQ-2 Radioplane provided targets to hone gunner fire, a skill that was lacking but needed due to the V-1, V-2, and enemy aircraft threats. The Firebee and Lightning Bug, outfitted

with cameras, filled the need for intelligence photography in non-permissive environments. The Lightning Bug also provided SIGINT and other capabilities where needed. Along with the primary question, the secondary questions looked at the wider scope of influence of UASs.

The secondary research questions were significant in understanding UAS usage by putting them into context. UASs were not isolated entities. Internal and external factors shaped their progression and modern-day status. One of the secondary questions was whether or not there was a thread of missed opportunities in the development of UAS technology, politically or fiscally, that led to underdevelopment of unmanned systems and programs. The secondary research question revealed a theme of long-term underdevelopment of UAS capabilities beginning in the 1940s. The Kettering Bug was a glimpse into what the systems could be and never came to completion.

The most detrimental moments were during the interwar periods where reductions in defense spending forced prioritization of research projects and many leaders focused on the short term rather than the long-term strategic potential of UASs. Additionally, technology developed at a slow pace, which inevitably made scientists recreate processes and products. Still, today's capabilities are currently not as developed as they might have been. Lieutenant Commander Delmar Fahrney realized in the 1940s the potential for weaponized UASs as attack platforms, but the Japanese attack on Pearl Harbor, caused reallocation of resources and Fahrney's ideas never gained momentum. UASs were ultimately weaponized in Vietnam; however, the continuity did not last and it took

another 30 years to weaponize them permanently in the early 2000s. This is exemplified when the RQ-1 was outfitted with hellfire missiles and renamed the MQ-1 Predator.[163]

Additional secondary questions included the following: What were the sentiments of manned aircraft pilots regarding UASs? Was there generalized acceptance of these technologies or an internal aversion to a concept that threatened the aviator status quo? While the data shows that these questions warrant further research, this thesis revealed distinct biases. Traditional pilots and senior leaders were unwilling to accept what UASs could deliver and meant for aviation. Unmanned aircraft could mean a dramatic culture shift, challenging pilots' sense of belonging, worth, and legitimacy.

The tertiary questions focused on what programs improved the capabilities of the operators and what type of doctrine or training programs developed UAS crews to standardize operations and ensure proficiency. Institutionalization came from the development of multiple UAS squadrons and groups that focused on the training and development of operators and systems. While many traditional pilots did not accept the transition to flying UASs, Air Force leadership created organizations that operated like any other flying unit. Capabilities may have been different, but standards and evaluations, training, scheduling, and tactics shops were all incorporated into the units to ensure quality operators.

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[163] RQ-1 stands for R = "Reconnaissance," Q = "Unmanned" first version, which changed to M = "Multi-role." The change happened soon after 11 September 2001, when senior military leaders realized these long-duration aircraft needed the capability to strike time-sensitive targets if necessary.

Conclusions

This paper tells a cautionary tale about UASs and future technologies regarding institutional progress and innovation. It shows how technology drove the change in aerial warfare despite the fact that, in 2003, the Lightning Bug saw its last combat missions over the Gulf with a total of five involved in opening salvos of the Second Gulf War.[164] UASs regressed from the forefront of military minds, but never completely disappeared. To retain the most qualified individuals, leadership needs to look at how it treats its people in technical jobs. Despite the misconception that unmanned aircraft created a manpower savings because there was not a person in the plane, they actually required more personnel to support flight operations.

Third, the Air Force must be mindful of how it views risk and balancing that with its sense of culture. UASs are about preventing risk to manned aircraft and keeping people out of harm's way. This explains the continued pressure regarding personnel in manned aircraft and the slow progression of unmanned aviation dominance into fighters, bombers, and mobility aircraft. While this may finally be changing, senior leaders routinely valued the culture of the Air Force above capabilities and risk aversion.

The UAS narrative is a cautionary tale of innovation. As new and advanced technologies are developed, the Department of Defense must be prepared to accept and integrate tools that enhance effectiveness. Cyberspace is one realm where the Department of Defense needs to stay ahead. The Department of Defense must have advocates for new capabilities that challenge the status quo. While the crux of the issue is the "man in the loop" mentality, the Air Force's love-hate relationship with unmanned aircraft must come

[164] Sloggett, 87-88.

to a head. In some ways, the Air Force has hindered its own progress and air superiority due to a failure to recognize the value of unmanned systems. The tipping point came when costs had dropped and technology advanced to a stage when military forces became so dependent on the information and capabilities UAVs provided that there was no turning back. Lastly, the Air Force and military as a whole must be mindful of the stagnation peacetime brings to development. The stressors of war breed innovation while the complacencies of peace stifle it.

Recommendations

UASs can be analyzed in a variety of ways; however, the most succinct and encompassing way to make recommendations is through the Army's DOTMLPF framework. DOTMLPF refers to doctrine, organization, training, material, leadership and education, personnel, and facilities. These recommendations are made by synthesizing the research and extrapolating lessons learned that could help the RPA communities of the future. "Ignorance of the history of unmanned aviation is costing us, the casual taxpayer and UAV developer alike, time and resources by retreading old ground. If this can help to prevent reinventing the wheel then it would have service its purpose."[165]

Doctrine

Doctrine is a fundamental source of standardized thinking and institutional legitimacy for the services. Historically, it has rarely included unmanned aircraft. UAS doctrine has developed in recent years through organizations such as the Air Land Sea Application Center that created multi-service tactics, techniques, and procedures

[165] Newcome, V.

regarding UAS. It is important to understand how UAS at all levels can enhance deep, close, and security missions. Tactics, techniques, and procedures need to be doctrinally codified.

Organization

The organization is an important part of the UAS construct because it adds validity to the systems. While two aviation groups were created during the Cold War and Vietnam, an entire wing was created in 2008 because of the insatiable demand for RPA. Organizationally, UAS units were modeled after traditional manned pilot units; however, the Air Force must view them as different. While there is some carryover of best practices, the inherent command and control of UAS create unique organizational structures. Air Force leadership must be open-minded enough to recognize and accommodate those differences, to maintain a high level of mission effectiveness.

Training

Training is always a difficult requirement to meet. UAS organizations struggled with maintaining currencies in the various mission sets for which they are responsible. This paper recommends in-depth analysis of training in UASs' unique nature and complexities. The Lightning Bug had 23 variants; many of those pilots had to train in and remain current in multiple versions. The ease of creating new types of UASs is a strength as well as a weakness because it forces unmanned aircraft aviators to learn more than one type of aircraft. While some of the UAS variants are similar, some have substantial hardware differences that affect flying characteristics.

Material

Material is the driving force behind DOTMLPF and, in the case of UASs, behind development despite institutional reluctance. They provided a capability that met a requirement. As UASs or RPA continue to improve, they must be created with a modular mentality. Variations are simply line-replaceable units that can be pulled on and off of the aircraft. The variations during Vietnam proved that single-capability aircraft stifle overall flexibility. UASs need to be created in a fashion that is agile and universal.

Leadership and Education

Leadership is reviewed through the Kotter model of organizational change. The following eight-stage process shows how leadership can create change in an institution. This is an important concept because UASs were a change in operations and culture and the failure in acceptance came from poor change practices in the organization.

1. Establish a sense of urgency.
2. Create a guiding coalition.
3. Develop a vision and strategy.
4. Communicate the change vision.
5. Empower broad-based action.
6. Generate short-term wins.
7. Consolidate gains and produce more change.
8. Anchor new approaches in the culture.[166]

[166] John P. Kotter, *Leading Change* (Boston, MA: Harvard Business Review Press, 2012), 23.

The cultural change failure regarding UAS during the 20th century revolved around leadership, mainly the lack of an advocate and voice of reason to promote capabilities and benefits, like Colonel Billy Mitchell did during the inception of manned aircraft. Change failed to occur because of a failure in the first two steps of the Kotter model. First, often there was not a sense of urgency to develop unmanned aircraft; as mentioned, during interwar periods they were often prioritized low on the hierarchy of organizational needs. However, during times of war in which capability gaps were created, there was a sense of urgency to develop UAS, which resulted in the variants of Vietnam. Unfortunately, the programs also lacked a guiding coalition. Not enough senior leaders were on board with the technology to execute the broad, sweeping changes required to stay on the leading edge of UAS technology. Never getting past the first two steps meant never reaching later steps.

Ironically, the technology proved so beneficial that, even without good urgency or guiding coalitions, UASs leaped to step six in which small, successful wins were attained, whether the execution of the mission or a development of innovation, in various pre-21st century conflicts. This kept UASs in the inventory and led to their continued use of despite institutional reluctance. Leaders must be mindful of how they prioritize UASs in the future. The sense of urgency must remain during times of peace and war. The other issue is that, over the past 100 years, no senior leaders have been adequately involved in UAS programs. In the 21st century, that is changing as more UAS leaders are making the rank of general officer; however, in the past the lack of community knowledge has hindered any true DoD-level backing.

Personnel

One of the most important aspects of the DOTMLPF process is the personnel. The stigma of being a UAS pilot or operator had effects in the 1970s and still does today. The Air Force, through leadership, must ensure that promotions are fair for everyone. The UAS communities cannot function as the "stepchildren" of the aviation community. Additionally, senior leaders must understand and translate the role UAS will play in the future. They are additional capabilities to add complexities to the enemy's battle calculus. As the technology continues to grow and mature, motivated and quality personnel need to be recruited to ensure that the UAS community can meet demand and head into the future of unmanned warfare.

Facilities

Facilities have always been an issue for UAS because of the sensitive nature of the aircraft classification and the search for operating airspace in which to train. RPA aviators today experience the same challenges of locations and facilities with amenities as the members of the 3205th Drone Group in 1951. The importance of facilities cannot be underestimated because of the morale factor they provide. The Air Force needs to learn the lessons of the past and pick locations good for family life, especially since modern-day UAS can be placed almost anywhere with very few limitations.

Areas for Further Research

This examination of unmanned aircraft throughout history has revealed numerous areas for future research. While the topic is of great interest to the public and seems likely to remain so, research needs to build a wider-ranging body of literature, not just talk

about what an aircraft is and look at the new and interesting concepts regarding the systems. This is important, since the systems are still relatively new and future researchers will look back to make links from what is written about now.

The first area for research is UAV doctrine and usage during the Gulf War. UAV doctrine is still in its infancy, but analysis of doctrine used at the drone groups or squadrons may be beneficial for understanding many connections to how UAVs were used in that time. The importance of UAVs echoes from the time before the Gulf War and taking the thread of use, opportunity, and doctrine development may shed light on important information.

The second area for future study involves the human factors involved with UAVs. Throughout history, these systems have been used out of necessity, with little consideration for physiological factors. Often the ground control stations from which pilots fly are not ergonomic or comfortable. Scrutinizing how human factors have evolved for UAS pilots and how the stresses, morale, and operations tempo have affected UAS operators in comparison to manned aircraft could reveal interesting information.

A third line of inquiry might be civilian and commercial progress and development in the UAV arena, specifically how and why it surpassed the military. One glaring reason is the profitable nature of maintaining research compared to the military. The military has too many cyclic changes to keep pace and too many divested interests. However, dissecting the civilian perspective on UAV advancement and marrying it to how it has affected military progress is important. Also, a critical vulnerability for the military is the chance that for-profit civilian organizations someday sell their weapons to another country.

The fourth area for further research is the impact of the scenario if all Air Force aircraft became unmanned and how this might affect the culture of the Air Force. Although hypothetical, it looks at the psychology of the service. Aircrew have a notion that they are irreplaceable and unmanned aircraft personnel are not trying to replace all manned aircraft; however, at some point in the future, this may become a real possibility. Understanding what the psyche is and could be may help to provide organization-level realization. Many military jobs have been replaced due to technology and manned planes could become a thing of the past.

The fifth area for further research is an investigation of UASs as a revolution in military affairs. The technological age is a military revolution based on the capabilities it provides. The computer, Internet, and GPS, to name a few technologies, have altered how the military wages, commands, controls, and institutes the instruments of power, be they diplomatic, informational, military, and economic. Technology has altered war. A sub-area for examination is the development of the ground control systems, simplex and duplex signals, and other capabilities that enabled UAS to fly over long distances. Unmanned aircraft provide new ways of considering time, space, and purpose. The ability of an RPA to kill people from thousands of miles away gives the U.S. military a distinct advantage worthy of research.[167]

[167] Rogers and Hill, 144-146.

BIBLIOGRAPHY

Books

Barnhart, Richard K., ed. *Introduction to Unmanned Aircraft Systems*. Boca Raton, FL: CRC Press, 2012.

Benjamin, Medea. *Drone Warfare: Killing by Remote Control*. Updated ed. London: Verso, 2013.

Birtle, Andrew J. *U.S. Army Counterinsurgency and Contingency Operations Doctrine, 1942-1976*. Washington, DC: U.S. Army Center of Military History, 2006.

Blom, John D. *Unmanned Aerial Systems: A Historical Perspective*. Fort Leavenworth, KS: Combat Studies Institute Press, 2010.

Boyne, Walter J. *Beyond the Wild Blue: A History of the United States Air Force, 1947-2007*. 2nd ed. New York: Thomas Dunne Books/St. Martin, 2007.

Dalamagkidis, Konstantinos, Kimon P. Valavanis, and Les A. Piegl. *On Integrating Unmanned Aircraft Systems Into the National Airspace System: Issues, Challenges, Operational Restrictions, Certification, and Automation: Science and Engineering*. Netherlands: Springer, 2013.

Everett, H. R. *Unmanned Systems of World Wars I and II. Intelligent Robotics and Autonomous Agents*. Cambridge, MA: The MIT Press, 2015.

Goddard, Stephen B. *Race to the Sky: The Wright Brothers Versus the United States Government*. Jefferson, NC: McFarland, 2003.

Grimes, Bill. *The History of Big Safari*. Bloomington, IN: Archway Publishing, 2014.

Kotter, John P. *Leading Change*. Boston, MA: Harvard Business Review Press, 2012.

Kozak, Warren. *Lemay: The Life and Wars of General Curtis Lemay*. Washington, DC: Regenery Pub., 2009. Kindle.

Langley, Samuel P., and Charles M. Manly. *Langley Memoir on Mechanical Flight*. Washington, DC: Smithsonian Institution, 1911.

Mikesh, R. C. *Japan’s World War II Balloon Bomb Attacks on North America. Smithsonian Annals of Flight*. Washington, DC: Smithsonian Institution Press, 1973.

Neiberg, Michael S. *Fighting the Great War: A Global History*. Cambridge, MA: Harvard University Press, 2005.

Newcome, Laurence R. *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles.* Reston, VA: American Institute of Aeronautics and Astronautics, 2004.

Olsen, John Andreas, ed. *A History of Air Warfare*. Washington, DC: Potomac Books, 2010. Kindle.

Paret, Peter, Gordon Alexander Craig, and Felix Gilbert, eds. *Makers of Modern Strategy: From Machiavelli to the Nuclear A*ge. Princeton, NJ: Princeton University Press, 1986.

Parker, Geoffrey, ed. *The Cambridge Illustrated History of Warfare: The Triumph of the West*. Cambridge, UK: Cambridge University Press, 1995.

Perrizo, John. *From a Ravens Perch: A Bird's View of Cold War Reconnaissance*. Ashwood, 2013.

Rogers, Ann, and John Hill. *Unmanned: Drone Warfare and Global Security*. New York: Pluto Press, 2014.

Singer, P. W. *Wired for War: The Robotics Revolution and Conflict in the Twenty-First Century*. New York: Penguin Press, 2009.

Sloggett, Dave. *Drone Warfare: The Development of Unmanned Aerial Conflict*. New York: Skyhorse Publishing, 2015.

Stephens, Alan. "The True Believers: Airpower between the Wars." In *The War in the Air: 1914–1994*, edited by Alan Stephens, 29-68. Maxwell Air Force Base, AL: Air University Press, 2001.

Stewart, Richard. *The U.S. Army Campaigns of the Vietnam War: Deeping Involvement 1945-1965*. Washington, DC: Center of Military History, 2012.

Zaloga, Steve. *Unmanned Aerial Vehicles: Robotic Air Warfare, 1917-2007*. Oxford: Osprey Publishing, 2008.

______. *V-1 Flying Bomb 1942–52: Hitler's Infamous 'Doodlebug' (New Vanguard).* Oxford: Osprey, 2005.

Government Documents

Air Land Sea Application Center. *UAS Multi-Service Tactics, Techniques, and Procedures for the Tactical Employment of Unmanned Aircraft Systems*. Joint Base Langley-Eustis, VA: Air Land Sea Application Center, 2015.

Aphrodite Mission No. Five. 388th BG Intelligence Report. Box 520.431B (August-November 1944)–520.4501 (6 June-16 November 1944). File 520.431B, 17 August 1944. Air Force Historical Research Agency, Maxwell Air Force Base, AL.

Bowen, Capt Wheeler B. Letter. Radio Controlled Target Detachment. United States Army. Box 539.902A (February-June 1945)–540.01 (16 October 1943-8 January 1944). File 539.9061 (5 November 1943-5 October 1945). Air Force Historical Research Agency, Maxwell Air Force Base, AL.

Cannon, Lt. Col. Walter C. Briefing. USAF Drone Program Operations. 10 June 1954. Box K-GP-TEST-3205-HI (January-June 1954)–KP-GP-TEST-3205-HI (January-June 1955). File K-GP-TET-3205-HI (Drone), January-June 1954. Air Force Historical Research Agency, Maxwell Air Force Base, AL.

Daubenspeck, MSgt Vincent L. Report. History of the 432d Tactical Drone Group: Davis Monthan Air Force Base Arizona, 1 October-31 December 1976. Box K-GP-RCN-432-HI (October-December 1976)–K-GP-RCN-432-HI (January-June 1977). File K-GP-RCN-432-HI (1 October 1976-31 December 1976). Air Force Historical Research Agency, Maxwell Air Force Base, AL.

Eaker, Ira, and Carl Spaatz. Letter. Preliminary Details of Williamson Project per request URAD CS 777 IE July 7. Norstad, Lauris: Papers, 1930–87. Box no. 7, 11 July 1944. Dwight D. Eisenhower Library and Museum, Abilene, KS.

Elder, Paul W. *Project CHECO Southeast Asia Report. Buffalo Hunter 1970–1972*. Hickam AFB, HI: Pacific Air Forces CHECO Division, 1973. Accessed 3 October 2015. http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA486697.

Hammack, Wayne. Unit History of the 3205th Drone Group: Jan 54 through Jun 54. Box K-GP-TEST-3205-HI (January-June 1954)–KP-GP-TEST-3205-HI (January-June 1955). File K-GP-TET-3205-HI (Drone), January-June 1954. Air Force Historical Research Agency, Maxwell Air Force Base, AL.

Instructions to Pilots. 471.6 Aphrodite Project CT. Box 520.431B (August-November 1944 v.2)–520.4501A (6 June-16 November 1944). File 520.431B v.2, August-November 1944. Air Force Historical Research Agency, Maxwell Air Force Base, AL.

Lyon, Lt H. P. 471.6 Aphrodite Project CT. Box 520.431B (August-November 1944 v.2)–520.4501A (6 June-16 November 1944). File 520.431B v.2, August-November 1944. Air Force Historical Research Agency, Maxwell Air Force Base, AL.

Ryan, Gen John D. Memorandum. Tactical Drones. 5 June 1971. Box 168.7041-41 (May 1971)–168.7041-54 (July 1972). Air Force Historical Research Agency, Maxwell Air Force Base, AL.

World's First Guided Missile: Kettering Bug. Speeches dedicating Kettering Bug to Air Force Museum, March 14, 1964. Box K289.9201-1, Air Force Historical Research Agency, Maxwell Air Force Base, AL.

Online Sources

Gates, Robert M. "Secretary of Defense Speech to Intelligence and National Security Alliance (William Oliver Baker Award)." U.S. Department of Defense, 21 May 2010. Accessed 2 April 2016. http://archive.defense.gov/Speeches/Speech.aspx?SpeechID=1474.

Hart, James. "Expanding the Size of the U.S. Military in World War II." Warfare History Network, 4 January 2016. Accessed 15 February 2016. http://warfarehistorynetwork.com/daily/wwii/expanding-the-size-of-the-u-s-military-in-world-war-ii/.

HistoryNet. "Vietnam War: Facts, Information and Articles About the Vietnam War." Accessed 6 January 2016. http://www.historynet.com/vietnam-war.

Shaw, Ian G. "The Rise of the Predator Empire: Tracing the History of U.S. Drones." Understanding Empire, 2014. Accessed 25 August 2015. https://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/.

Valavanis, K., and George J. Vachtsevanos. *Handbook of Unmanned Aerial Vehicles*. Dordrecht: SpringerReference, 2014. Accessed 28 September 2015. http://dx.doi.org/10.1007/978-90-481-9707-1.

Periodicals

Degaspari, John. "Look, Ma, No Pilot!" *Mechanical Engineering* 125, no. 11 (November 2003): 42-44.

"Eye in the Sky." *Military History* 25, no. 3 (July 2008): 12. Military and Government Collection, EBSCOhost. Accessed 25 October 2015.

Fanning Jr, William J. "The Origin of the Term 'Blitzkrieg': Another View." *Journal of Military History* 61, no. 2 (April 1997): 283-302.

Fanton, Ben. "View From Above the Battlefield." *America's Civil War* 14, no. 4 (September 2001): 22-29.

Glines, C. V. “Ford’s Forgotten Aviation Legacy.” *Aviation History* 18, no. 5 (May 2008): 29-33.

Hall, Cargill R. “Reconnaissance Drones: Their First Use in the Cold War.” *Air Power History* 61, no. 3 (2014): 20-27.

Hopkins, Sarah, and Robert Scheina. “America's Champion Aeronaut in the Civil War.” *Military Images* 33, no. 4 (2015): 42-44.

Hotz, Robert. “The Promise of RPVs.” *Aviation Week and Space Technology* (January 1973): 7-10.

Keane, John, and Stephen Carr. “A Brief History of Early Unmanned Aircraft.” *John Hopkins APL Technical Digest* 32, no. 3 (2013): 558-561.

Mallin Sr., Jay, and Robert Scheina. “Innovative Technologies and American Soldiers of Fortune.” *Army Magazine* 64, no. 9 (2014): 76-77.

Miller, Barry. “Unmanned Aircraft Gain Favor.” *Aviation Week and Space Technology* 7, no. 4 (November 1970): 67-68.

______. “USAF Widens Unmanned Aircraft Effort.” *Aviation Week and Space Technology* 7, no. 4 (November 1970): 46-52.

Pardoe, Blaine. “Frank Luke Jr.: A Dauntless Spirit.” *Air Power History* 56, no. 3 (Fall 2009): 4-13.

Poll, Ian. “The Evolving Capability of UAV Systems.” *NATO’s Nations and Partners for Peace* 52, no. 2 (June 2007): 130-132.

Siegel, Nan, and Robert Scheina. “Legacy of Flight.” *Aviation History* 13, no. 6 (July 2003): 74.

Stamp, Jeffrey, and Robert Scheina. “Aero-Static Warfare: A Brief Survey of Ballooning in Mid-nineteenth-century Seige Warfare.” *Journal of Military History* 79, no. 33 (July 2015): 769-770.

Weeks, Albert L. “In Operation Aphrodite, Explosive-Laden Aircraft Were to Be Flown Against German Targets.” *World War II* (May 2000): 66.

Papers, Reports, Theses

Clark, Lt. Col. Richard M. “Uninhabited Combat Aerial Vehicles: Airpower by the People, For the People, But Not with the People.” Cadre Paper No. 8. Maxwell AFB, AL: Air University Press, August 2000.

Ehrhard, Thomas P. *Air Force UAVs: The Secret History*. Arlington, VA: Mitchell Institute Press, 2010. Accessed 21 September 2015. http://aviationweek.com/site-files/aviationweek.com/files/uploads/2015/05/1970-%20UAVs%20in%20the%20Vietnam%20War.pdf.

Gaub, Maj Darin L. "The Children of Aphrodite: The Proliferation and Threat of Unmanned Aerial Systems in the Twenty-First Century." Monograph, School of Advanced Military Studies, Fort Leavenworth, KS, May 2011.

Kohn, Richard H., and Joseph P. Harahan, eds.. "Air Interdiction in World War II, Korea, and Vietnam: An Interview with Gen. Earle E. Partridge, Gen. Jacob E. Smart, and Gen. John W. Vogt, Jr." USAF Warrior Studies. Office of Air Force History, Washington, DC, September, 1986.

Lowe, Donald R., Holly B. Story, and Matthew B. Parsons. "U.S. Army Unmanned Aircraft Systems (UAS)—A Historical Perspective to Identifying and Understanding Stakeholder Relationships." Joint Applied Project, Naval Postgraduate School, Monterey, CA, June 2014.

Meger, James P. "The Rise of the Unmanned Aerial Vehicle and Its Effect on Manned Tactical Aviation." Master's Thesis, U.S. Army Command and General Staff College, Fort Leavenworth, KS, June 2006.

Trefz, LCDR John L. "From Persistent ISR to Precision Strikes: The Expanding Role of UAVs." Paper, Naval War College, Newport, RI, May 2003.